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The Hydrological Open Air Laboratory - HOAL Petzenkirchen Catchment observations complementing lysimeter measurements

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Zusammenfassung

Das im Westen von Niederösterreich liegende HOAL (Hydrological Open Air Laboratory) Petzenkirchen ist ein 66ha großes Einzugsgebiet mit Schwerpunkt auf der Beobachtung hydrologischer Prozesse. Durch das Institut für Kulturtechnik und Bodenwasserhaushalt Petzenkirchen (Bundesamt für Wasserwirtschaft) wurden bereits seit 1945 Beobachtungen in diesem Versuchseinzugsgebiet durchgeführt, insbesondere des Abflusses und der Schwebstoffkonzentrationen. Im Rahmen des Doktoratskollegs Wasserwirtschaftliche Systeme startete das Projekt „HOAL“ im Jahr 2009 als eine Kooperation zwischen dem Bundesamt für Wasserwirtschaft und dem Institut für Wasserbau und Ingenieurhydrologie (Technische Universität Wien). Unter anderem wurden Abflussmessstationen an 10 Zubringern im Einzugsgebiet eingerichtet, Messungen der Wasserqualität und mikrobiologischer Parameter, Messungen der atmosphärischen Flüsse, ein Bodenfeuchtemessnetzwerk und Grundwassersonden installiert. Das Ziel des hochaufgelösten Monitorings ist es, die Transport- und Umwandlungsprozesse von Wasser, Nährstoffen, Schadstoffen, Sedimenten und Energie zu verstehen. Diese Ergebnisse können damit als ergänzende Daten für Lysimeterfragestellungen herangezogen werden.

Schlagwörter: Einzugsgebiet, Monitoring, Prozessentstehung, Massenbilanz, Wasserhaushalt

Summary

The Hydrological Open Air Laboratory (HOAL) Petzenkirchen is a 66ha research catchment located in the western part of Lower Austria that aims at observing hydrological processes. The Institute for Land and Water Management Research Petzenkirchen (Federal Agency of Water Management), has carried out catchment observations since 1945, in particular regarding runoff and sediment concentrations. In the frame of the Doctoral Programme on Water Resource Systems, the HOAL Project was initiated in 2009 as a cooperation between the Federal Agency of Water Management and the Institute of Hydrology and Water Resource Management (Vienna University of Technology). Among other monitoring equipment, runoff flumes at 10 tributaries within the catchment, a soil moisture network and groundwater sensors were installed, monitoring of water quality and microbial parameters and monitoring of atmospheric fluxes started. The object of the high resolution monitoring is to better understand the transport and transformation processes associated with water, nutrients, pollutants, sediments and energy. These data collected in the HOAL are therefore complementary to lysimeter data.

Keywords: catchment, monitoring, processes, mass balance, water balance

Introduction

The Hydrological Open Air Laboratory (HOAL) Petzenkirchen is located in the western part of Lower Austria. It is 66h in area, land-use is mainly agricultural and has a humid climate. The mean annual temperature is 9,3°C and the mean annual rainfall is 716mm/yr. Catchment elevations range from 268 to 323 m a.s.l. and the mean slope is 8%. The dominant soil types in the catchment are Cambisols and Planosols (FAO 1998) with infiltration capacities from medium to poor. Due to using the land for agricultural purposes, sub-surface drainage systems have been installed in the 1950's to lower the water table. Furthermore, the upper part of the catchment stream (approximately 25%) has been piped in the 1950's to extend the agricultural area. This led to a current length of 590m of the stream that drains the catchment (EDER et al. 2010).

The observations of hydrological processes in this research catchment date back to 1945. The Institute for Land and Water Management Research (Federal Agency of Water Management) in Petzenkirchen started to observe the catchment behaviour and the quality and quantitiy of the stream water. In the frame of the Doctoral Programme on Water Resource Systems (DK WRS), the HOAL Project was initiated in 2009 as a cooperation between the Federal Agency of Water Management and the Institute of Hydrology and Water Resource Management (Vienna University of Technology). This doctoral programme is funded by the Austrian Science Fund (FWF) and has been designed to run over a period of 12 years. The key priorities are cutting edge research, interdisciplinary training and international networking (BLÖSCHL et al. 2012). Currently eight international doctoral students from six nations are researching in the HOAL.

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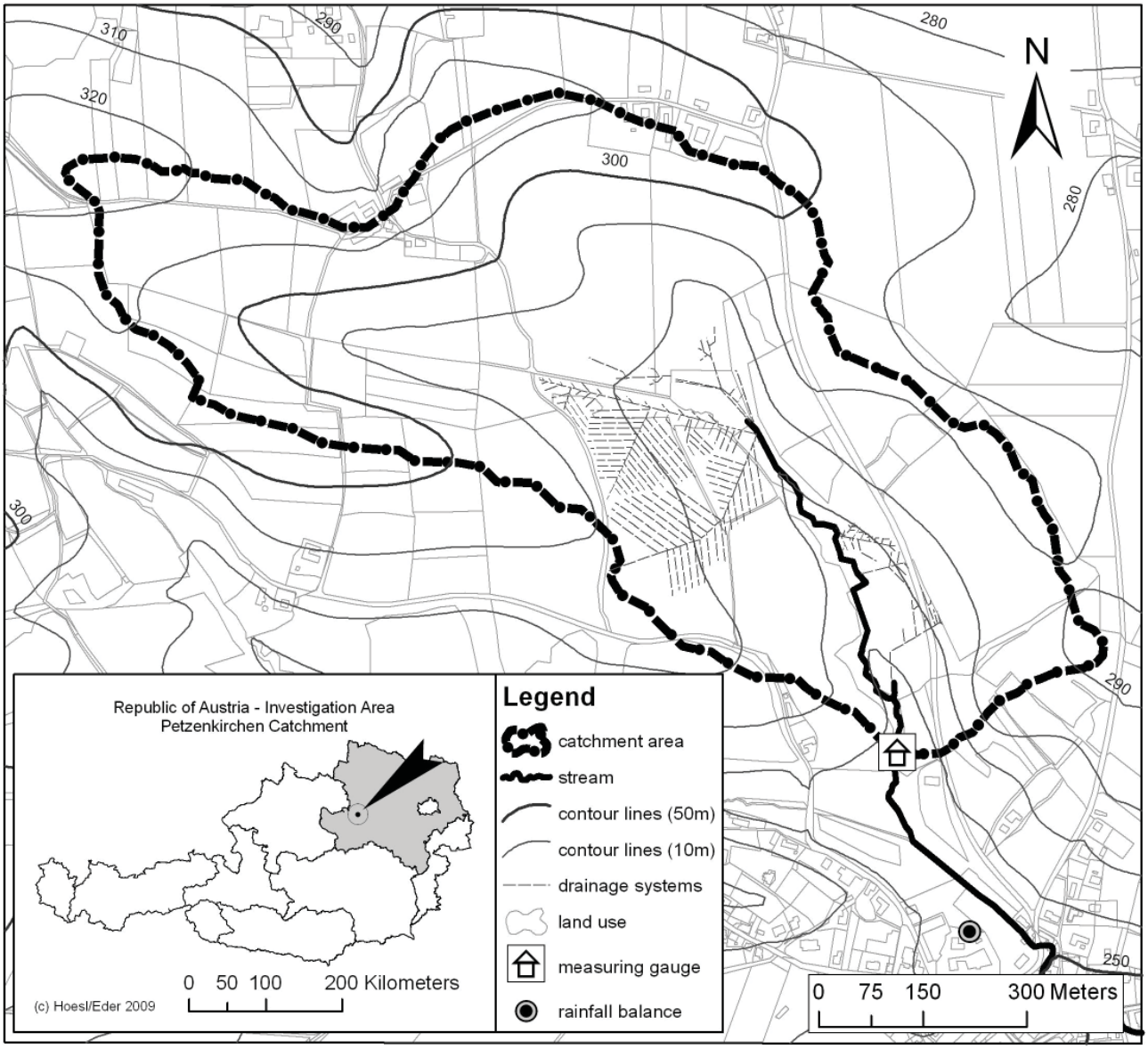

Figure 1: **HOAL Petzenkirchen (EDER et al. 2010).**

With the start of the project, the catchment was instrumented in a comprehensive way. Automatic discharge measurements at all catchment tributaries were installed where, additionally a number of water quality and microbiological parameters were monitored, a flux tower was set up, complemented by two mobile towers, a soil moisture network and groundwater piezometers were established. With this equipment a permanent and automatic monitoring of the area with a high temporal and spatial resolution is achieved.

Research topics and technical equipment

Current research in the HOAL focuses on understanding precipitation, runoff and sedimentation processes, catchment scale evapotranspiration, the spatial and temporal variability of soil moisture, nutrient and pollutant pathways as well as turbulent wind load on structures. Precipitation is measured in the catchment using four rain gauges. The precipitation data is transferred automatically and can be displayed with an online database tool. This tool is used for several data types that are collected in the catchment and displays the data in real time. Therefore the screening and initial data quality check of the data is straightforward.

The discharge of the catchment stream and of the tributaries to the catchment stream is measured every minute, using calibrated H-flumes and V-notch weirs and a pressure transducer to monitor water level (EDER et al. 2010). Each weir has its own calibration curve.

At the catchment outlet, automatic suction samplers are installed to take event water samples from the stream. These samplers are triggered by a certain water level in the H-flumes and the samples are analysed for chemical and physical parameters. This installation is also used at the start of the stream and at two erosion gullies, which observe occurring event water from overland flow from an agricul-

tural field. The water samples from the erosion gullies are used for erosion and soil loss studies in the catchment. In addition, aerial photos from the catchment are taken from a motorized paraglider to create digital terrain models by using photogrammetry.

In order to estimate nutrient and pollutant pathways the samples of the automatic suction samplers at the catchment outlet and manual samples from the catchment tributaries are analysed. In addition, four devices for measuring enzymatic activity (GLUC) of water are operated. The enzymatic activity can be used as a surrogate for bacterial faecal pollution.

Evapotranspiration is measured at a flux tower which is located in the centre of the HOAL catchment. It is equipped with sensors for measuring air temperature, wind speed and direction, radiation, relative humidity, soil moisture and soil temperature, snow depth and rain drop size distribution and rainfall intensity. A scintillometer and three eddy covariance systems are operated, two of them as mobile devices in order to monitor different parts of the catchment.

A soil moisture network consisting of 21 permanent and 11 temporal stations in the crop land is installed. The soil moisture and soil temperature sensors are measuring at depths of 5, 10, 20 and 50cm and the data is transferred remotely to a local computer. One use of the soil moisture data is the calibration of soil moisture satellite data (VREUGDENHIL et al. 2013).

An upcoming installation will be the mounting of wind load sensors at the mast of the flux station, to identify wind loads on structures.

Early results and outlook

Early results from the HOAL catchment have been published by EDER et al. (2010, 2014), EXNER-KITTRIDGE et al. (2014), and VREUGDENHIL et al. (2013). Due to the comprehensive instrumentation in the catchment, a detailed spatial and temporal monitoring of this research area has been achieved. This will lead to a better understanding of the hydrological processes within the catchment, including the mass balances of water, nutrients and pollutants, sediments and energy. Since the focus is on the spatial patterns, the data will be able to link the local scales of lysimeters to the small catchment scale.

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