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Hydrological research in small catchments – an approach to improve knowledge on hydrological processes and global change impacts

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Much of fundamental hydrological knowledge is obtained in small catchment studies. Well instrumented research plots and small catchments provide an opportunity to improve our understanding of the hydrological cycle. The knowledge gained at these scales can be used to solve some practical issues related to the hydrological cycle such as flood protection, groundwater resources replenishment or soil and water conservation. Long-term data observed in small catchments located in areas less affected by human activities can contribute to climate change impacts assessment. Moreover, small catchments are natural laboratories which help in the preparation of new generations of specialists (e.g. Braunschweig Declaration, 2013). We testimony an ongoing growing interest of the hydrological community in field research, which is also manifested by well attended conference sessions devoted to presentation of results from small catchments.

A few past issues of Journal of Hydrology and Hydromechanics were already devoted to hydrological research in small catchments. In 2003 (vol. 51, no. 3), the journal published selected articles based on presentations from the ERB2002 conference, of the Euromediterranean Network of Experimental and Representative Basins. ERB is an informal network of European hydrologists focusing on small catchments, which shares results of hydrological research at the biannual conferences organized since 1986 (http://www.ih.savba.sk). In 2006 (vol. 54, no. 2), an overview of the status of hydrological research in small catchments of Slovakia and Czech Republic was published.

This issue includes selected contributions presented at the ERB2014 conference (de Lima and de Lima, 2014) and a few other regular contributions submitted to the Journal of Hydrology and Hydromechanics. The ten articles address several topics related to catchment hydrology and are briefly introduced below. The ERB2014 conference was held in Coimbra (Portugal), from 9 to 13 September, 2014, at the Department of Civil Engineering of the University of Coimbra (http://www.ci.uc.pt/imar/erb2014/).

Development in hydrological knowledge depends on new ways of data acquisition. Technological progress and the use of new techniques are expected to continue opening new perspectives in better understanding the hydrological cycle. J. de Lima et al. (this issue) present a novel technique of rain drop size estimation based on infrared thermography. Whilst simple and expedite, it provides histograms of mean rain drops' diameter that are comparable with results provided by disdrometer measurements. Infrared thermography is thus being investigated as an attractive alternative approach in low-cost soil erosion studies.

Rainfall estimation is also discussed in the article by Brocca et al. (this issue). Their approach is based on the idea that rainfall can be estimated inversely from soil moisture data. They use an algorithm called SM2RAIN, which assumptions are successfully checked using synthetic data and measured soil moisture and rainfall data from ten sites across Europe.

Another application of infrared thermography presented by R. de Lima et al. (this issue) focuses on estimating surface velocities in shallow flows. Laboratory and field experiments indicate that infrared thermography provides results that are comparable with the results obtained using commonly used techniques such as Acoustic Doppler Velocimeter and dye tracers. The study also shows that infrared thermography can play an important role in measuring overland flow velocities in field conditions when the shallow flows restrict the use of those measuring techniques.

Runoff formation is an important topic in hydrological research. Two articles in this issue focus on runoff formation in catchments affected by human activities. Boulet et al. study the hydrological implications of introducing large-scale eucalypt plantations in mountainous catchments in the north-central Portugal. They conclude that annual rate of the overland flow is low. Subsurface runoff which is dominant, originates from the matrix flow and pipe flow. Matrix flow is correlated with soil moisture content. Pipe flow starts with saturation of soil bottom but without saturation of the entire soil profile. Zumr et al. study prevailing storm runoff generation mechanisms in an intensively cultivated agricultural catchment in the Czech Republic. They show that shallow subsurface runoff may be dominant also in cultivated land. The article evaluates the links between runoff generation and sediment transport using a new index called "suspended sediment flux"; this study also considers the direction of the discharge-turbidity hysteresis loops.

Integrating hydrology and ecology offers potential for interdisciplinary studies at the catchment scale. Based on such an approach, Pfister et al. (this issue) examine the presence and flushing of aerial diatoms in three catchments with contrasting physiographic characteristics in Luxembourg, Slovakia and Oregon (USA). Aerial diatom communities showed a clear increase during rainfall-runoff events in wetter catchment conditions. It suggests that diatoms could be used as potential tracers of hydrological connectivity.

Two other articles in this issue present practical application of hydrological research conducted in small catchments. Dagnew et al. study the impact of conservation practices on runoff and soil loss in the Ethiopian Highlands. Runoff volume was found to significantly decrease after installation of infiltration furrows, soil bunds with infiltration ditches and

plantation of selected vegetation species on the bunds. However, sediment concentration decreased only marginally. The authors discuss the effectiveness and weaknesses of different soil and water conservation measures, under different field conditions. While the infiltration furrows were effective on the hillsides where rain water could infiltrate, the infiltration was restricted on the flat bottom lands which become saturated with the progress of the monsoon rain. De Girolamo et al. discuss an empirical approach recently proposed by the authors to evaluate hydrological changes in a temporary river. This approach uses a simple hydrological index (IARI) to identify river segments where the hydrological regime has changed significantly, followed by a classification of the hydrological alteration. The results obtained for River Celone, in southern Italy, are used to show the applicability of the approach, which aims at defining the water quality status and the planning of streamflow management activities in temporary rivers.

Most of the catchments worldwide remain ungauged or are poorly instrumented. Extrapolation of hydrological data from gauged to ungauged catchments (see e.g. Blöschl et al., 2013) and how to deal with scarce hydrological information are therefore important issues in hydrological research. The article by Parajka et al. (this issue) provides insight into the effect of station density for predicting daily runoff using top-kriging interpolation. Based on the analyses of data from 555 gauges in Austria the authors conclude that top-kriging interpolation is superior to hydrological model regionalization if station density exceeds approximately two stations per 1000 km^2.

Analyses of the impacts of climate variations on hydrological regimes are crucial for understanding alterations in the hydrological cycle. Blahušiaková et al. (this issue) present an analysis of trends in runoff, precipitation, air temperature and snow cover in a large mountain basin of central Slovakia. The study shows that the 1980s could be identified as a turning point in all monitored hydroclimatic variables, in their study area. Observed runoff trends are not always consistent with trends predicted by the previous impact studies based on climatic scenarios.

The guest editors would like to acknowledge the effort of the authors and reviewers of the articles presented in this issue and hope that they are of interest to the readers of Journal of Hydrology and Hydromechanics.

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