WESS: an interdisciplinary approach to catchment research

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Predicting how environmental change (climate, land use, etc.) will affect hydrological response and water quality on the long term is a grand challenge in Environmental Earth Sciences. It requires fundamental understanding of functioning of catchments and landscapes:

- How do they process pollutants on the large scale (natural attenuation of diffuse pollution)?
- How are processes such as flow, transport and reaction coupled?
- What is the role of interfaces (atmosphere–plants–soil–groundwater–surface waters)?
- How can we monitor and model water and solute fluxes across the different scales involved?

To meet these challenges, a number of novel research programs and networks focusing on entire catchments or landscapes have recently been established such as CUASHI

(Toran and Hooper 2004) or TERENO (Zacharias et al. 2011). “Catchment Research” is the second Topical Issue (TI) in Environmental Earth Sciences with a focus on international hydrological research. Most of the material has been provided by the Water Earth System Science Competence Cluster (WESS) founded by the Universities of Tübingen, Stuttgart, and Hohenheim together with the Helmholtz Centre for Environmental Research, UFZ (Grathwohl et al. 2013). The TI “Catchment Research” is a follow-up of the IWAS issue (Kalbus et al. 2012) which was dealing with Integrated Water Resources Management in different climate-hydrological sensitive areas in the world.

“Catchment Research” is organized in three sections, starting with results from the initial period of the WESS project, followed by invited studies from catchment research in Europe, Asia and South America. The last part of the volume presents overview and technical papers on the development of terrestrial observatories, in particular, the TERENO network. A “News and Views” contribution concerning the networking and community efforts of the Water Science Alliance initiative is provided at the end of this issue (Krueger and Teutsch 2013).

The first section of “Catchment Research” consists of contributions from the Water Earth System Science Competence Cluster. Grathwohl et al. (2013) provide a comprehensive overview of the WESS research concept and field sites. Studies presented put emphasis on experimental investigations in various sub-catchments of the Neckar River basin, e.g., using fluorometry (Lemke et al. 2013), assessing hyporheic exchange processes (Osenbrück et al. 2013), and delineating subsurface heterogeneity underneath the river bed (Doro et al. 2013). David et al. (2013) are investigating the influence of sewer overflows to accumulation patterns in river bed sediments. The second

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section deals with hydrological characterization and modelling of surface and subsurface systems including travel time analysis and more complex reactive transport processes at the hillslope scale (Woehling et al. 2013; Selle et al. 2013; Maier et al. 2013). Schwientek et al. (2013) and Ruegner et al. (2013) look at the nitrate cycle in an agricultural area and the water quality in rivers related to urban and agricultural pressure. Pause et al. (2013) present the results of a multi-sensor campaign (with airborne and field experimental data) to characterize the shallow subsurface. Gayler et al. (2013) assess the relevance of processes in crops and the subsurface for evapotranspiration, i.e. processes at the interface to the atmosphere. Delfs et al. (2013) present a new concept for coupling process based surface/subsurface flow models including dynamic flow processes in the unsaturated zone.

The second part of “Catchment Research” assembles a number of hydrological studies from Asia (Middle East, Saudi Arabia), South America (Brazil) and Europe (Austria, Switzerland). Engelhardt et al. (2013a) present a palaeo-groundwater model of the Arabian Peninsula for assessing the groundwater recharge during more humid periods in the Pleistocene as well as Mid Holocene and continuous depletion of the groundwater resources during the Late Holocene. A second modelling approach has been applied for the estimation of groundwater recharge in more recent times (Engelhardt et al. 2013b). Two further studies are dedicated to the Zarqa River catchment and Western Dead Sea Escarpment, two areas on the opposite sides of the Jordan River to improve the understanding of surface runoff and related groundwater recharge mechanisms in semi-arid areas (Schulz et al. 2013; Gräbe et al. 2013; Mallast et al. 2013). Diniz Gonçalves et al. (2013) present a groundwater model of the Pípiripau watershed, a Federal District of Brazil with extreme population growth and related increase of water demand. Several hydrological studies from Austria and Switzerland are described in the second part of the international section with emphasis on Alpine catchments as a contrast to the semi-arid regions beforehand. Altdorff et al. (2013) and Huggenberger et al. (2013) deal with hydrogeophysical methods for non-invasive measurements and the description of aquifer-surface water interaction in typical subalpine river systems in Switzerland. Finally, two contrasting catchment studies from Austria are presented by Klammler et al. (2013), and Strasser et al. (2013) investigating a mountainous catchment in Upper Styria and a basin used for both drinking water supply from groundwater as well as for agricultural leading to nitrate leaching.

The final part of “Catchment Research” contains several overviews and some more technically oriented pieces of work. Richter et al. (2013) report on lessons learnt and future perspectives concerning Integrated Water Resources

Management and the implementation of the EU-Water Framework Directive in Germany. An overview provided by Ghasemizadeh and Schirmer (2013) deals with subsurface flow contributions to the hydrological cycle. Rinke et al. (2013) developed a comprehensive online monitoring system at Rappbode reservoir within the TERENO Bode observatory, the largest drinking water reservoir in Germany. The Berchtesgaden National Park (Bavaria, Germany) as a platform for interdisciplinary catchment research in an alpine region is presented by Marke et al. (2013), investigating trade-offs between the natural resources in the park area and socio-economy. Elmer et al. (2013) demonstrate the application of a similar methodology with focus on ecosystem dynamics in an artificial catchment in Lusatia (Germany). TEODOOR is the data portal of TERENO (Kunkel et al. 2013) and offered as a gate to terrestrial data access from different observatories. Finally, Rink et al. (2013) present a framework for exploration, integration, validation and visualization of comprehensive terrestrial data sets. Data integration (Rink et al. 2012) and simulation platform development (Kalbacher et al. 2012) as well as the subsequent establishment of continuous work flows (Kolditz et al. 2012)—as described in previous issues—are important ingredients for interdisciplinary research and community building in Environmental Earth Sciences as documented in the present “Catchment Research” Topical Issue (Gratwohl et al. 2013).

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