A MULTIDISCIPLINARY INVESTIGATION OF RUNOFF GENERATION PROCESSES IN TWO EXPERIMENTAL HEADWATER BASINS IN LUXEMBOURG

S. Wrede [1,2], L. Pfister[1], A. Krein[1], J. Juilleret[1], T.A. Bogaard[2], S. Uhlenbrook[3]

[1] Centre de Recherche Public - Gabriel Lippmann, Belvaux, Luxembourg.
[2] Delft University of Technology, Delft, The Netherlands.
[3] Department of Water Engineering, UNESCO-IHE Delft, The Netherlands
S.Wrede@tudelft.nl

Abstract

In most river systems the majority of stream length comprises of headwater streams. These headwaters are located at the water-land interface and are conditional for water quality and hydrological response of large parts of the river basins. Traditionally, experimental hydrology has been focusing on the investigation of selected experimental headwater basins. However, a thorough assessment and systematic understanding of runoff generation processes of these "Aqua Incognita" (Bishop *et al.*, 2008) at the headwater scale is still lacking and remains one of the major research goals in experimental hydrology.

To identify the main controls of runoff generation, this study investigates and compares two characteristic headwater catchments of the 297 km² Attert basin in the Grand Duchy of Luxembourg. The Attert basin is located at the contact zone between the schistose Ardennes massif (northern part) and the sedimentary Paris Basin (southern part). The headwater basins are considered as being relatively simple structured and representative of this contrasting lithology. While the forested Weierbach headwater basin (0.4 km²) is characteristic for the Devonian schist of the North, the partly forested Huewelerbach headwater basin (2.7 km²) reflects the lithology of the Jurassic sandstone and Triassic marls of the South (Figure 1).

The headwater research follows a multidisciplinary approach and combines traditional hydrological methods with partly new and innovative techniques from different disciplines: hydrology (i.e. hydrometry, geochemical and isotopic tracers), hydrogeophysics (electrical resistivity tomography (ERT)) and pedology (soil drillings and sampling).

Preliminary results of the combination of investigation methods revealed more complex runoff generation processes than previously anticipated from traditional hydrological approaches. Different runoff components and hydrological responses could be identified by means of hydrochemical tracers and hydrometric data (Kies *et al.*, 2005; Krein *et al.*, 2007). The application of the ERT method further revealed the variable and complex subsurface configurations and their importance for runoff generation in the basins. These techniques helped in combination with drillings and soil sampling to better understand the origin and flow pathways in the catchment. While the sandstone basin is mainly characterised by a constant groundwater component occurring at the sandstone-marls interface and a fast rainfall-runoff reaction due to the presence of saturated surface flow on marly substratum, the hydrological response in the schist basin strongly differs. Here, the runoff generation is controlled by the impermeable bedrock topography and the depth of the saprolitic zone that supplies a dynamic and delayed shallow groundwater component (Van den Bos *et al.*, 2006).

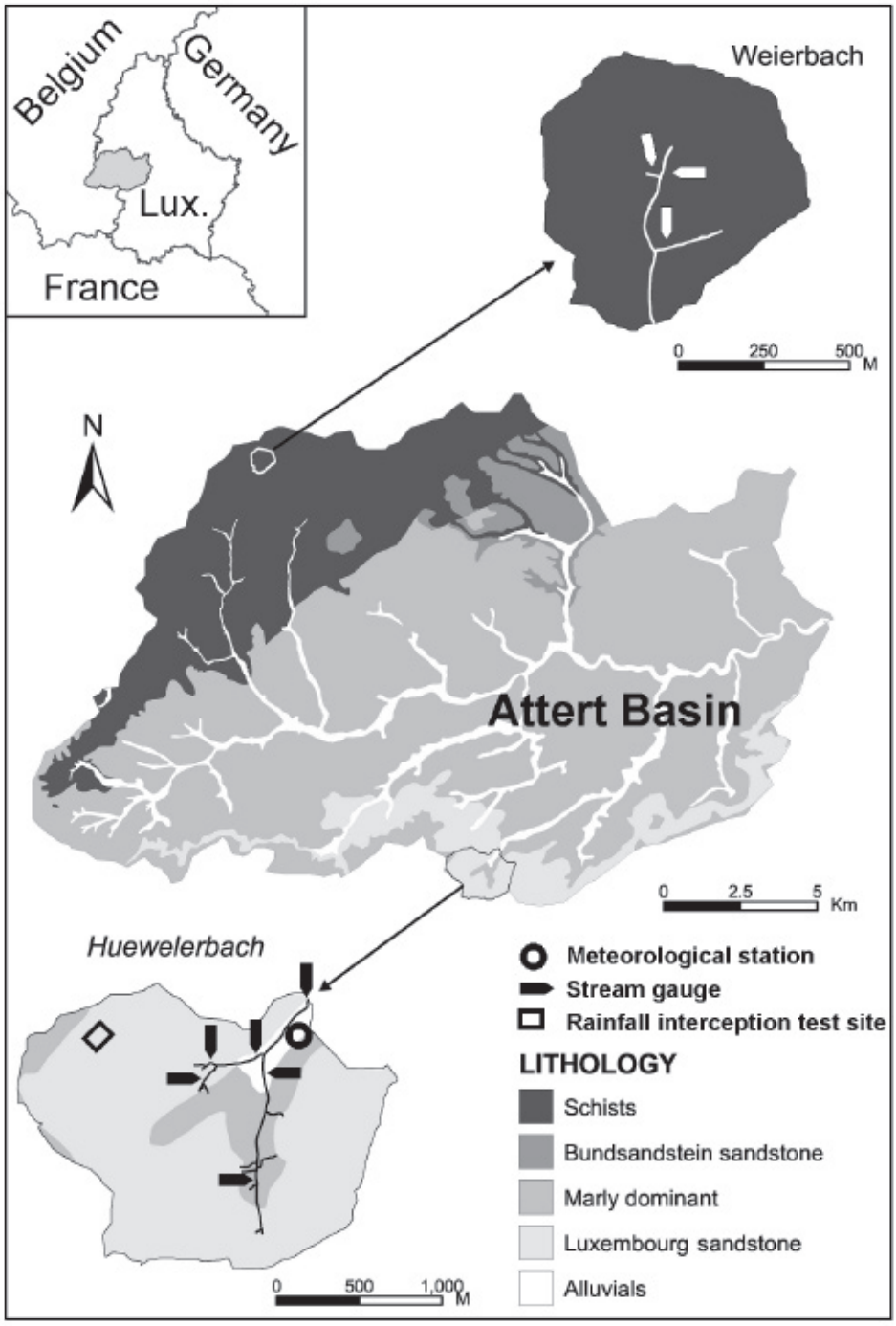

Figure 1. Location of headwater catchments and measurement sites.

The application of methods and perspectives from different disciplines proofed to be a valuable and complementary approach to gain a better insight into the catchment functioning and revealed the differences in hydrological and hydrochemical responses as a consequence of their geology.

Acknowledgements

The authors would like to thank the Ministry of Culture, Higher Education and Research of Luxembourg for the support of this research.

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