Comparative Estimation and Assessment of Initial Soil Moisture Conditions for Flash Flood Warning in Saxony

Thanh Thi Luong, Rico Kronenberg, Uwe Spank, Thomas Grünwald, Uta Moderow, Firas Al Janabi, Niels Schütze and Christian Bernhofer
TU Dresden, Faculty of Environmental Sciences, Institute of Hydrology and Meteorology

European Geosciences Union General Assembly, Vienna, Austria, 24 – 28 April 2017

1. Introduction

Flash Floods are known as highly destructive natural hazards due to their sudden appearance and severe consequences. In Saxony/Germany flash floods occur in small and medium catchments of low mountain ranges which are typically ungauged. Besides rainfall and orography, pre-event moisture is decisive, as it determines the available natural retention in the catchment. The Flash Flood Guidance concept according to WMO and Marco Borga (University of Padua) will be adapted to incorporate pre-event moisture in real-time flood forecast.

Picture 1: Damaged federal road B170 in Kipsdorf (flood of the river Rote Weißeritz). 13th of August 2002

(Photo taken from: „Jahrhunderflut in Sachsen", Dresdner Druck- und Verlagshaus 2002)

2. Objectives

- Developing threshold-based flash flood warning method.
  - Delivering quickly simulated antecedent soil moisture in ungauged catchments in low mountain range based on measured and radar precipitation, topography, land-used and soil information.
  - Finding the point in time when precipitation exceeds the retention potential of the catchment.

3. Methods: Water Balance Model

- The lumped-parameter model BROOK90 is used and tested for well-observed catchments.
- Physical meaningful parameters (like albedo or soil porosity) are taken by measurements.
- "free" parameters (like percentage of lateral flow) were calibrated objectively by PEST (Model-Independent Parameter Estimation and Uncertainty Analysis) with the target on discharge at the Catchment.

4. Discharge and Soil Moisture Relation

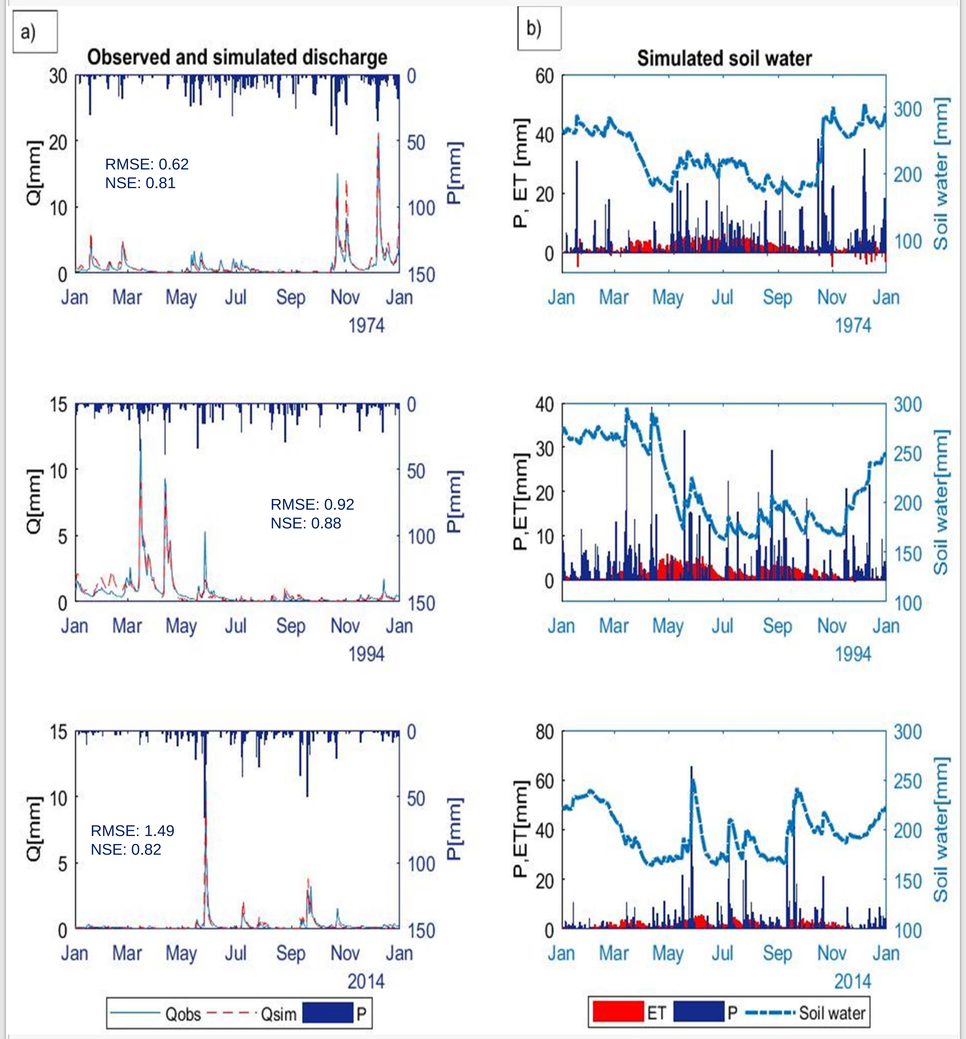

Figure 1: Daily discharge (a) and evapotranspiration and soil moisture (b) evaluation at Wernersbach catchment in 1974, 1994 and 2014

- Discharges (Qobs, Qsim) are in good agreement, however the peaks are not completely matched.
- Soil water has shown its wetness in the winter months (until March/April) and rain fall events and reduced in the summer months (until October).

5. Discharge Evaluation

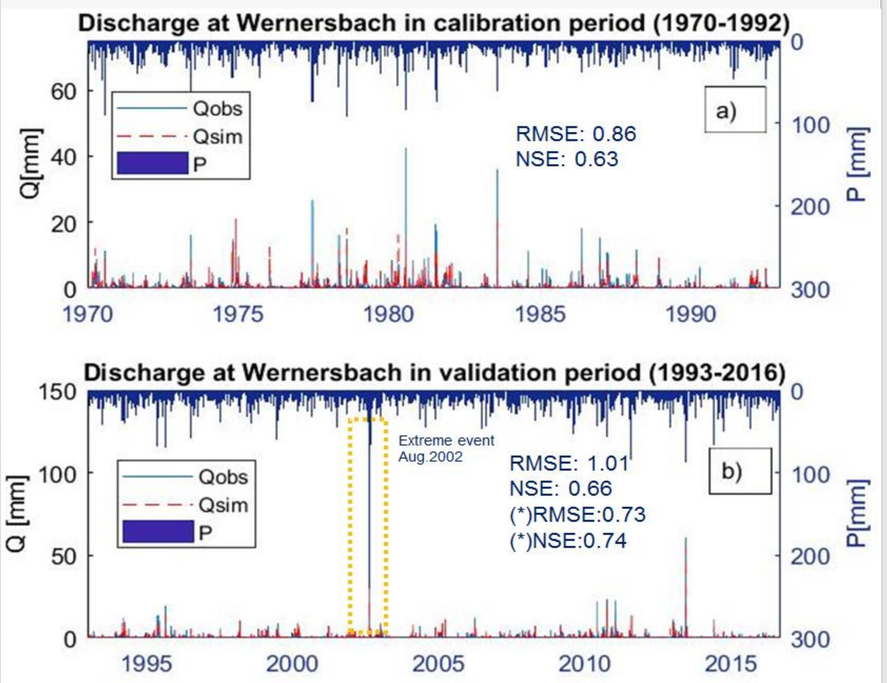

Figure 2 Goodness of fit of observed and simulated discharge at Wernersbach catchment in the calibration period (1970-1992)(a) – and Validation period (1993-2016)(b)
(*) The extreme event in August 2002 (100 years flood) is excluded due to the damage of the gauge station

- The peaks of discharges from extreme events such as 2002 were underestimated which caused the high value of RMSEs.
- NSEs stay relatively consistent for both time frames. It shows the model's significance with the value of 0.74 when the extreme event 2002 excluded.

6. Conclusions and Outlook

- The relation between discharge and soil moisture outputs from BROOK90 can be applied to define the corresponding critical soil moisture for each event by setting thresholds for 'high' flows instead of the concept of soil saturation.
- Parameterization for the coniferous forest (Wernersbach) in low range mountain is conducted → parameter set for certain land use und topography is feasible to obtain.
- Flood risk potential method identification based on antecedent soil moisture can be implemented by estimating the catchment water retention and predicted precipitation.
- The model results can be improved by simulating in shorter periods with its corresponding measurements.
- Sensitivity analysis → influenced of important parameters for the ET and flow processes will be investigated.

Luong, Thanh Thi
Technische Universität Dresden
Institute of Hydrology and Meteorolgy
Chair of Meteorology
Pienner Str. 23 Tel.: +49 351 4631341
01735 Tharandt
Germany E-Mail: thanh_thi.luong@tu-dresden.de

References

Federer, C.A. 2002. BROOK 90: A simulation model for evaporation, soil water, and streamflow. http://www.ecoshift.net/brook/brook90.htm.
Spank, U., & Bernhofer, C. (2008). Another Simple Method of Spectral Correction to Obtain Robust Eddy-Covariance Results. *Boundary-Layer Meteorology*, *128*(3), 403–422. https://doi.org/10.1007/s10546-008-9295-9
Grünwald, T., & Bernhofer, C. (2007). A decade of carbon, water and energy flux measurements of an old spruce forest at the Anchor Station Tharandt. *Tellus B*, *59*(3), 387–396. https://doi.org/10.1111/j.1600-0889.2007.00259.x
Borga, M., Gaume, E., Creutin, J. D., & Marchi, L. (2008). Surveying flash floods: gauging the ungauged extremes. *Hydrological Processes*, *22*(18), 3883–3885. https://doi.org/10.1002/hyp.7111
...

Acknowledgement

- These investigations are part of the research project "Extreme events in small and catchments (EXTRUSO)" funded by the EU ESF 'Nachwuchsforschergruppen' program under grant no. 100270097.
- Many thanks to Dr.U.Spank and Dr.T. Grünwald, scientists at institute of Meteorology, TU Dresden, for data und technical support.