# Exploring the Variability of Short-term Precipitation and Hydrological Response of Small Czech Watersheds


**Petr Kavka [1], Luděk Strouhal [1], Lenka Weyskrabová [1], Miloslav Müller [2] and Petr Kožant [3]**

1) Czech Technical University in Prague; Faculty of Civil Engineering; Dept. of Irrigation, Drainage and Landscape Engineering
2) Czech Academy of Sciences;, Institute of Atmospheric Physics; 3) Sweco Hydroprojekt, a.s.

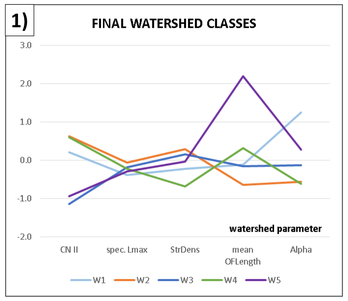


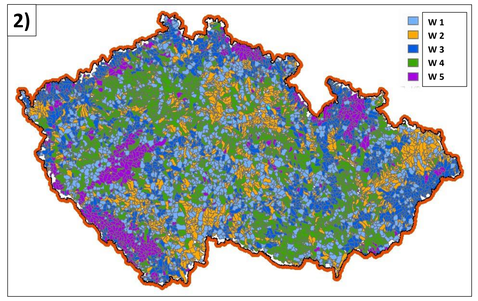
## Abstract

The short-term rainfall temporal distribution is known to have a significant effect on the small watersheds' hydrological response. In Czech Republic there are limited publicly available data on intensity patterns of short-term rainfalls which could be utilized both by scientists and design planners. In presented project six generalized 6-hours hyetographs were derived from 10 years of radar and gauging stations data. These hyetographs are used in a complex sensitivity analysis focused on a rainfall-runoff response of small watersheds. It takes into account the uncertainty related to type of the hydrological model, watershed characteristics and main model routines parameterization. Five models with different methods and structure are considered and each model is applied on 5 characteristic watersheds selected from a classification of 7700 small Czech watersheds. In the last step the variability of outputs will be assessed in the context of economic impacts on design of landscape water structures.


## B) Small watersheds classification

In order to analyse how the watershed properties contribute to the overall runoff response variability 7740 Czech small watersheds were classified by the K-means clustering method using 5 factors expected to affect the runoff response: 1) SCS curve number (CN), 2) specific maximum flow length, 3) stream network density, 4) mean length of overland flow paths and 5) watershed shape coefficient Alpha. From each class a typical representative was chosen for consecutive modelling.



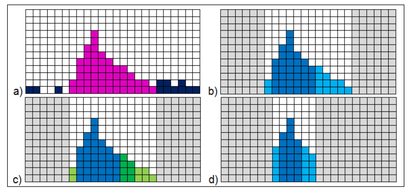

***1)*** *Final variogram of five watershed's properties*

***2)*** *Spatial distribution of small watershed classes in Czech Republic*

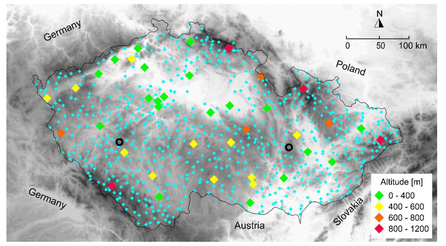
***3)*** *Selected representative watersheds for hydrological modelling*


## A) Analysis of rainfall intensity temporal distribution

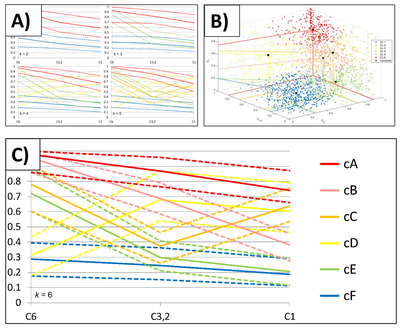
Reference 6-hour rainfall episodes were extracted from radar-derived precipitation time series with a time resolution of 10 minutes, adjusted by daily data from rain gauges. Six clusters of episodes were distinguished by three indexes that quantify the precipitation concentration within time steps from one to six hours. For individual clusters, the average course of precipitation intensity was expressed with synthetic hyetographs.




*Creation of concentration indexes*




*Topography of the Czech Republic with positions of two Czech weather radars (circles), rain gauges used in the adjustment of radar data (small signs), and synoptic stations distinguished with respect to the mean altitude of the corresponding radar 1 by 1 km pixel*

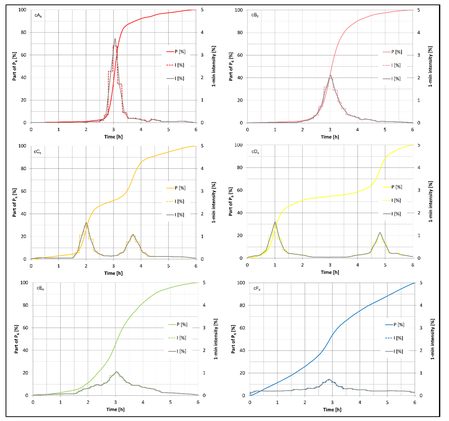



***A)*** *Parallel coordinate plots of clusters*

***B)*** *3-D scatter plot of the final clustering*

***C)*** *Final parallel coordinate plot of clusters*

***D)*** *Percentage of episodes belonging to individual clusters when increasing their number* ***k***



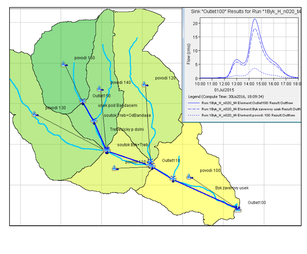

*Synthetic storm hyetographs for 6 distinguished clusters. Dashed lines indicate the hyetographs before smoothing by the moving average*

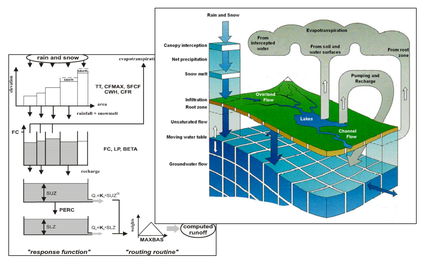
## C) Representative hydrological models application

With the aim to asses the runoff response uncertainty related to the model selection as well as to promote standing methodologies an overview of hydrologic and erosion models used in Czech Republic was elaborated. Models were classified according to phenomena description and calculation routines and representative models for further uncertainty analyses were selected.

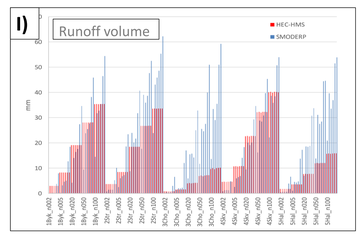
| Model | Spatial resolution | Effective rainfall method | Routing method |
|---|---|---|---|
| **Smoderp 2D** | Fully distributed | Physical (Phillip) | Physical (diff. wave) |
| **Topmodel** | Lumped – semidistr. | Physical (G&A) / conceptual | Konceptual (time travel f) |
| **MIKE SHE** | Fully distributed | Physical (Richards) | Physical (diff. wave) |
| **HMS** | Lumped – semidistr. | Conceptual (SCS-CN) | Unit hydrograph |
| **KINFIL** | Lumped (conc. surface) | Physical (G&A) | Conceptual / physical |

**Tab:** selected representative hydrological models

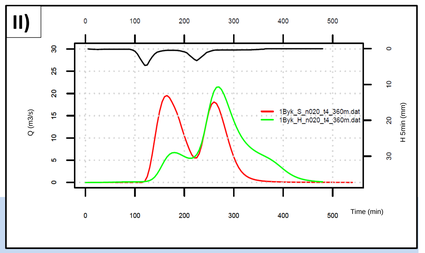





In selected hydrological models a complex sensitivity analysis of rainfall-runoff response on a large set of variables is being carried out. The models are applied in 5 representative watersheds. For each combination of model and watershed 30 rainfall scenarios combining generalized hyetographs with totals of different return period are simulated.




Other scenarios will be used to address the model parameters uncertainty. Finaly the response characteristics (peak discharge, time of the peak and runoff volume) are to be compared and the individual sources of uncertainty evaluated.




***I)*** *Runoff volume HEC - HMS and SMODERP comparison*

***II)*** *HEC - HMS and SMODERP response for two peaks rain scenario*

## Web application

Web applications and web services that provide design precipitation and other related output are available at:

**www.rain.fsv.cvut.cz**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## Literature


Bližňák, V., Kašpar, M., Müller, M.: Radar-based summer precipitation climatology of the Czech Republic. Int. J. Climatol., submitted

Müller, M., Kašpar, M., Bližňák, V.: Analysis of short-term rainfall time structure by concentration indexes. Atmos. Res., submitted.



**Contact: Petr Kavka | petr.kavka@fsv.cvut.cz | CTU in Prague | FCE | Thakurova 7 Prague 166 29**