

# SIMULATION OF RAINFALL – RUNOFF PROCESS FOR EVALUATION OF VARIABILITY WATER REGIME IN SEVERAL SMALL BASINS

**J. Buchtele, M. Tesař**

*Institute of Hydrodynamics of the ASCR, Prague, Czech Republic  
miroslav.tesar@iol.cz*

## **Introduction**

Different changes appear in the water regime in many basins. Diverse fluctuations and tendencies are induced by natural, i.e. mostly climatic oscillations and by antropogenic activities. Climatic conditions influence the oscillations vegetation cover in the annual cycle, but they create the conditions for its development in the scale of years also. This could be also the cause of different oscillation and/or tendencies in evapotranspiration demands and consequently for water regime changes.

As the information about the attributes and the extents of vegetation cover in the basins are mostly available only for several last decades the reliable evaluation of possible tendencies in long time series of flows is complicated. For these reasons it is desirable to take into account some other forms of the extent and production, or yields, of vegetation cover as the Figure 1 illustrates. Agricultural production, i.e. yields of grain, has been considered as the effective phenomenon already years ago (Keller, 1970) the role of forest cover, or more exactly deforestation in some subbasins of Labe River is an actual problem (Buchtele et al., 2006) and the efforts exist to simulate runoff also under these conditions.

Nevertheless, the natural conditions in the basins are frequently considered as valid even in the situations when in the past some changes in the water regime occurred. For example in the upper part of the Labe River basin, near town Třeboň, many large fishponds exist for more than four centuries and affect seriously the discharge of one tributary of Labe River. For the recent periods, with shorter time series and also in smaller basins the similar situation creates possible problem in identification of model parameters for rainfall-runoff process, which are the possible tool also for ascertaining appearing changes.

In such circumstances the differences between observed and simulated flows can be appropriate tools, and that helps also to re-determinate eventually the period for the proper calibration, i.e. interval with prevailing natural conditions.

Notice: It is assumed usually that for identification of model parameters the series of data 5 – 10 years are reasonably long, but flood cases and apparent dry periods appearing in the available data sets are desirable.

The data sets from experimental basins and, of course, of national hydrological service are frequently relevant for the implementation of rainfall-runoff model. Still, in both cases the re-calibration can be sometimes useful. For these reasons the data of several experimental basins have been used in this presentation.

## Used data and tools

For simulation of rainfall-runoff process model SAC-SMA (Burnash, 1995) and BROOK '90 model have been calibrated for the experimental basins presented in Table 1, where some output of simulation are apparent. Moreover these models have been used for Husinec reservoir with the basin  $P=202 \text{ km}^2$ , for which 30 years daily series were used for runoff simulations.

## Results of simulations

The differences between observed and simulated discharge  $dQ = Q_{\text{obs}} - Q_{\text{sim}}$  are presented for several of those basins in the following figures, where also accumulated differences (sum  $dQ$ ) are mostly displayed, which can provide another view on possible tendency. In each basin the specific changes can be noticed:

- Figure 2 for Liz basin shows that differences  $dQ$  have occurred probably due the instability of stream channel after large flood 2002 and due the changes in water level monitoring in the year 1993.
- Figure 3 with the outputs of Husinec reservoir basin, where comparison of SAC-SMA model and Brook model are displayed, shows the similar tendency, which indicates that runoff after stationary period temporary increased, probably due to extended arable areas and damages in forest caused by insects.
- Figure 4 for two neighbouring basins indicates, by accumulated differences (sum  $dQ$ ), that diverse damages in forest exist, caused by acid rains in this area which is situated near heavy damaged Krušné Hory.
- Figure 5 presents effects of scheduled deforestation, i.e. greater discharge and newly decreased discharge after interrupting deforestation is also visible.

The intention has been to decrease the role of annual cycle of climatic condition in evaluation of appearing natural and/or artificial changes of runoff. The results suggest that the improvement of simulation could be reached by the more precise evaluation of evapotranspiration demands as it is correlated with vegetation cover conditions.

Table 1. Characteristics of basins and simulations

Basin	Basin Area [km <sup>2</sup> ]	H <sub>min</sub> [m a.s.l.]	H <sub>max</sub> [m a.s.l.]	Run-off [l/s]	Precipitation [mm/y]	R	Abs. dif. [%]
Liz - Šumava Mts.	0.990	828	904	8.50	840	0.8192	18.1
Lysina - Doupov. Mts.	0.273	1024	640	2.10	896	0.8354	21.9
Pluhův Bor - Doupov. Mts.	0.216	829	960	0.52	864	0.8153	27.1
Ěervík - Beskydy Mts.	1.850	949	602	37.90	1125	0.7452	24.8
Ráztoka - Beskydy Mts.	2.080	690	1084	60.00	1243	0.8549	24.0

Notice: R - coefficient of correlation between  $Q_{\text{obs}}$  and  $Q_{\text{sim}}$ ; Abs. Dif. - absolute standard error

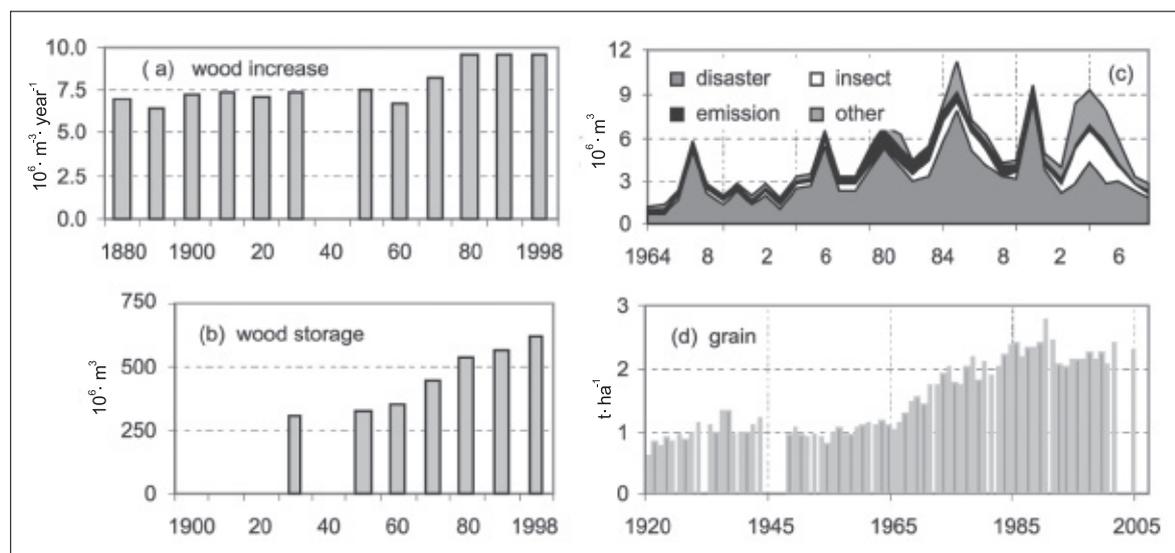


Figure 1. Forest cover, disasters and grain tendency in the country during past century

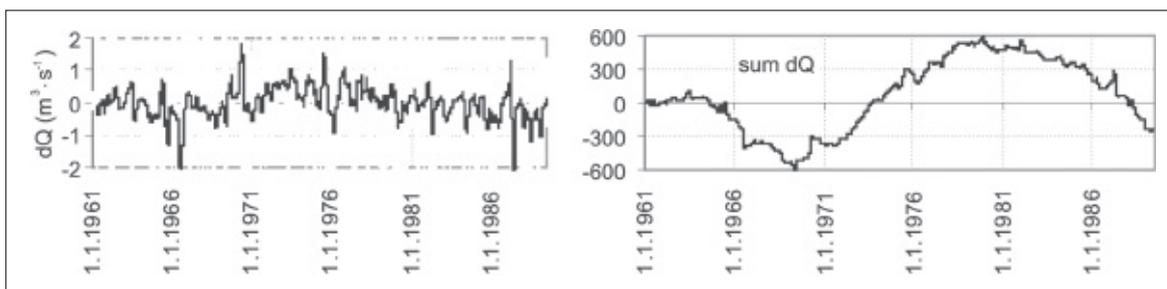


Figure 2. Differences of observed and simulated discharge  $dQ = Q_{obs} - Q_{sim}$  (moving average - 30 days) and accumulated values (sum dQ) of Liz basin

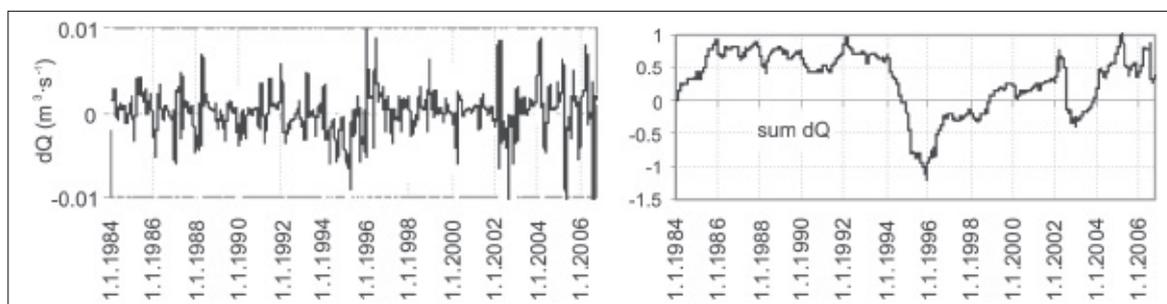


Figure 3. Differences  $dQ = Q_{obs} - Q_{sim}$  (moving average - 3 months) and accumulated values (sum dQ) of Husinec reservoir basin

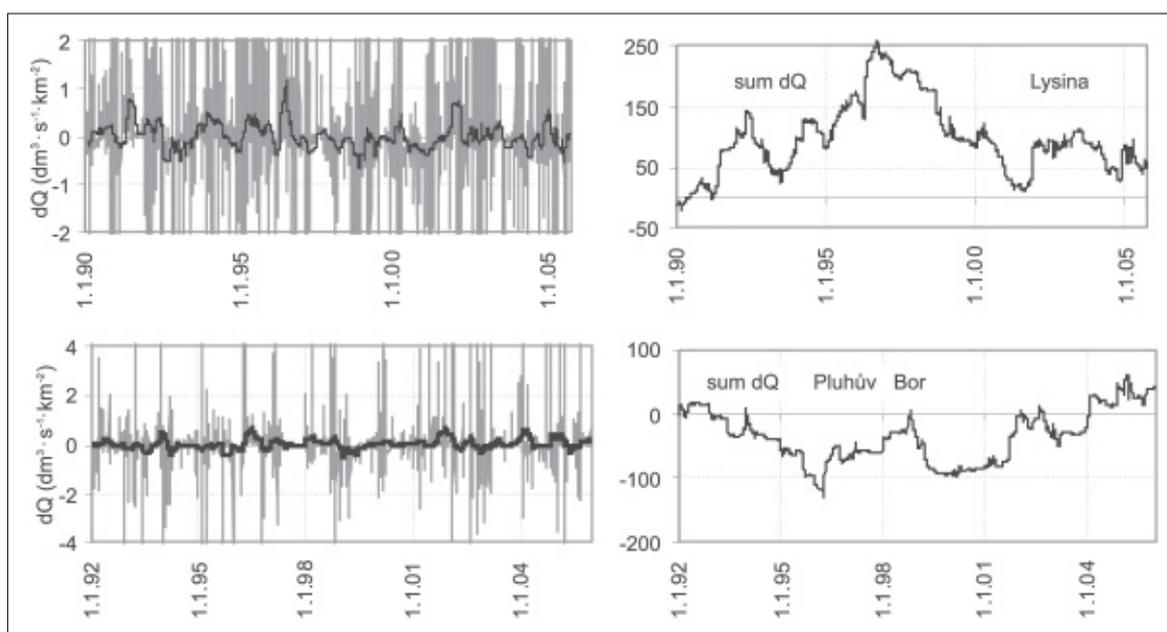


Figure 4. Differences  $dQ = Q_{obs} - Q_{sim}$  (moving average - 93 days) and accumulated values (sum dQ) of Lysina and Pluhův Bor basins

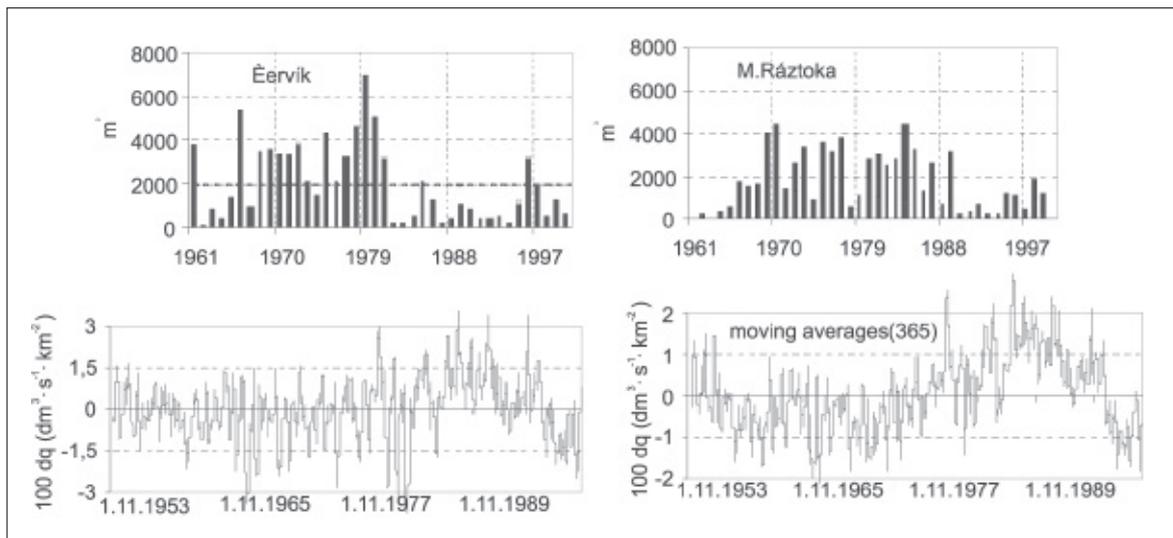


Figure 5. Volumes of wood cutting and differences of observed and simulated discharge  $dQ = Q_{obs} - Q_{sim}$  smoothed with  $m=365$  days

## Acknowledgements

The research presented in this paper was supported by the Ministry of Environment of the Czech Republic (Project No. SP 1a6/151/07).

## References

- Buchtele, J., Buchtelová, M., Fořtová, M., 2006: *The simulation of rainfall-runoff process for Czech Elbe River basin using one hundred years daily series* (in Czech). Workshop ČVTS Praha Extrémní hydrologické jevy v povodích: 81–91.
- Burnash, R.J.C., 1995: *The NWS River Forecast System - Catchment modelling*. In: Singh, V.P. (ed.): *Computer Models of Watershed Hydrology*. Water Resources Publ. ISBN No. 0-918334-91-8.
- Keller, R., 1970: *Water balance of German Federal Republic*. Symp. on world water balance, 1970, Reading, IAHS/UNESCO Publ. No. 92.