# INFLUENCE OF FORESTATION ON RUNOFF IN SMALL EXPERIMENTAL BASINS

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It is generally accepted that forests play a major role in many components of the water cycle. The comprehensive bibliographical reviews in literature demonstrate the wide range of research topics in this field, regarding both "the impact of forests on the water cycle" and "the role of trees in specific climatic conditions". It is mainly believed that forest cover reduces runoff, although some assert otherwise (Humbert and Najjar, 1992; Bloeschl et al., 2007). The reduction in runoff varies according to the forest species as well as the season, and is by no means constant for all expanses of area or for all rainfalls. The aim of the paper was to evaluate the forestation influence on mean annual runoff and extreme runoff in the vegetation and non-vegetation period in the basins with different vegetation cover. In the study the results of long-term hydrological observations from two experimental microbasins of IH SAS are presented: 1. Rybarik- an agricultural basin (0.119 km$^2$), period 1964/65–2005/2006: and 2. Lesny – a forested basin (deciduous - hornbeam) (0.086 km$^2$), period 1964/65–1993/94.

## Results

The hydrological balance in experimental microbasins was analysed using daily precipitation totals and daily runoff, measured in both basins during the period 1964/65–1993/94. In the Lesny microbasin the discharge measurements were interrupted in the period 1994/95–2003/04 (Figure 1).

In the Rybarik microcatchment the wettest hydrological year was 1965/66 (from November to October). The annual precipitation amount reached 996 mm and annual runoff was 408 mm. The driest year was 1992/93 with 124 mm of annual runoff. Values of basic runoff characteristics in experimental microbasins from the period 1964/65–1993/94 are summarized in Table 1. The runoff from agricultural basin is higher by 45%.

### Influence of forestation on mean annual and seasonal runoff

Using the values of observed mean annual runoff R and mean annual precipitation P, the dependence of annual runoff on annual precipitation was analyzed. By similar precipitation evident higher runoff can be observed from agricultural basin; e.g. by precipitation of about 500 mm is the difference in runoff about 50 mm in favor of the agricultural basin, by precipitation of about 900 mm the runoff from agricultural basin is higher by 100 mm (Figure 1a).

Table 1. Basic runoff characteristics in experimental microbasins of IH SAS Rybarik and Lesny for the period 1964/65–1993/94

| Basin | Unit | Rybarik | Lesny |
|---|---|---|---|
| Basin area | [km$^2$] | 0.119 | 0.086 |
| Forested area | [%] | 10 | 90 |
| Min/Mean/Max basin altitude | [m a.s.l.] | 369/401/434 | 350/380/415 |
| Long-term mean annual precipitation totals | [mm] | 743.9 | 732.5 |
| Long-term mean annual runoff | [mm] | 237.2 | 163.4 |
| Runoff coefficient | | 0.318 | 0.223 |

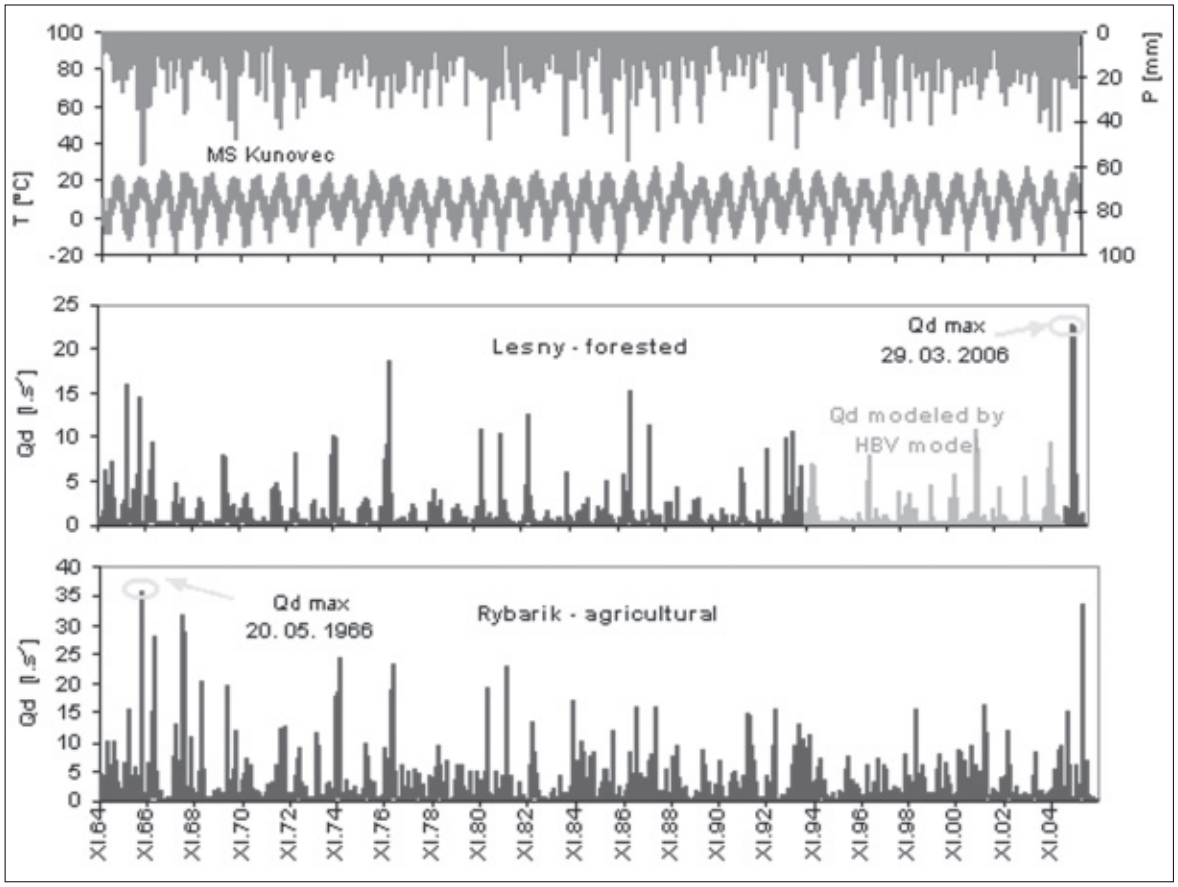
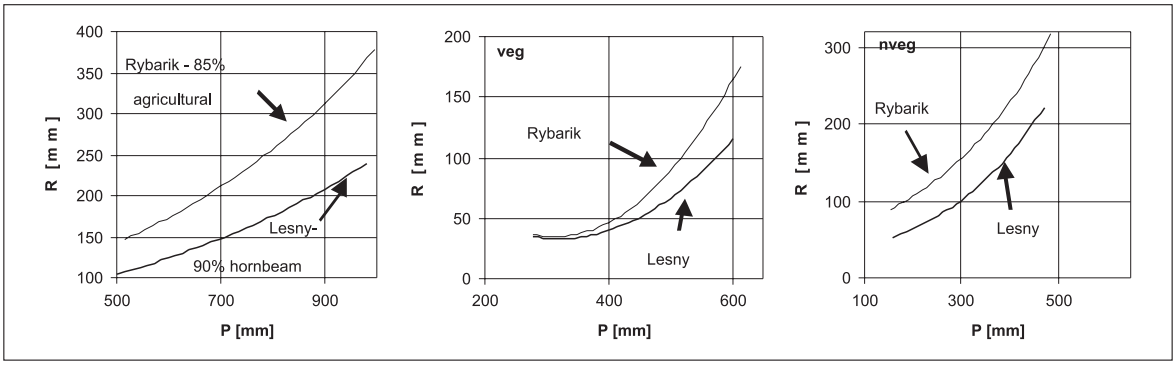



Figure 1. Time series of mean daily discharge in the Rybarik and Lesny microbasins and mean daily precipitation and air temperature in station Kunovec




Figue 2. Dependence of runoff (R) on precipitation (P) in two experimental microbasins of IH SAS (period 1964/65-1993/94). a) yearly values; b) vegetation period; c) non-vegetation period

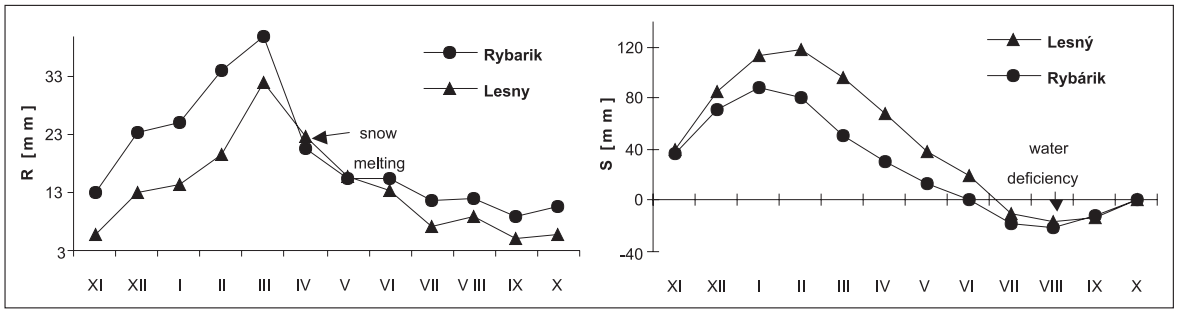



Figure 3. Comparison of the long-term mean monthly runoff depths *R* in [mm] and long-term mean monthly water storage *S* (microbasins Rybarik, and Lesny), 30-year period

Using the winter-spring and summer-autumn values the dependency of runoff on precipitation totals was analyzed for the vegetation period and non-vegetation period. The dependence on precipitation is plotted on Figs. 2b-c. From the figures we can observe that the forest has evident influence on runoff with increase in non-vegetation period. In vegetation period during wet years higher runoff is in agricultural basin. In dry summers the hornbeam forest is consuming the water for its vegetation and reduces the basin runoff (Figure 2b). More evident results were achieved by analyzing the monthly values of observations.

## Influence of microbasin forestation on mean monthly runoff regime

For the evaluation of forestation influence on long-term mean monthly runoff *R* and water storage *S* regime, the long-term mean monthly runoff, precipitation and evapotranspiration values from analysed microbasins were used (period 1964/65–1993/94, Figure 3). From the long-term monthly water balance it is evident, that the agricultural microbasin Rybarik has lower catchment retention capacity *S* by 40%. The higher basin runoff is contributed by the months from June to March, when the runoff from agricultural microbasin Rybarik is significantly higher than that from forested microbasin Lesny.

## The influence of forestation on annual maximum specific discharges ($q_{max}$)

The observed values of the annual maximum specific discharges $q_{max}$ are presented in Figure 4, from the microbasins Rybarik and Lesny for the period 1965–2006. To compare the extreme runoff conditions in both basins, the statistical estimation of theoretical distribution functions was applied. For the estimation of the theoretical distribution functions DVWK (1999) methodology was applied. It is based on the possibility to use a wide variety of the theoretical probability distribution functions, with three methods for estimation

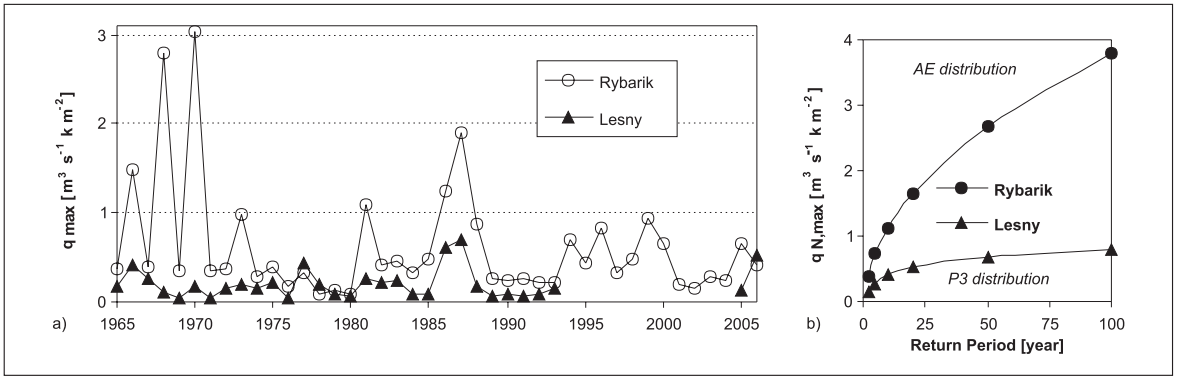



Figure 4. a) Maximum annual specific discharges in the two microbasins Rybarik – agricultural, and Lesny – forested. b) *N*-year maximum specific discharges calculated in the two microbasins

of their parameters and with a simultaneous application of combined statistical test for decision as to their selection. The best selected distribution function for the maximum annual specific discharge in Rybarik was the General extreme value distribution (AE) and for Lesny data the Pearson III distribution (P3), (Figure 4b).

The extreme runoff from the agricultural microbasin Rybarik is considerably higher, e.g. the 50-year maximum specific discharge is 4 times higher in comparison to the estimated maximum specific discharge in microbasin Lesny.

## Conclusion

Following conclusions can be made from the comparison of the hydrological regime and water balance in the analysed microbasins situated in similar geological, orographical and climatical conditions:

- the catchment forestation can cause the decrease of 1/3 in annual runoff, approximately,
- the increase of annual runoff is significantly higher in the non-vegetation period, when the agricultural basin soils are bare,
- during April to June the runoff conditions in both basins are similar and the discharges are comparable,
- In dry summers the hornbeam forest is consuming the water for its vegetation and reduces the basin runoff,
- in the case of extreme runoff conditions, the deforestation can cause enormous increase in runoff (e.g. the 50-year maximum specific discharge was 4 times higher in Rybarik microbasin in comparison to the estimated maximum specific discharge in microbasin Lesny).

## Acknowledgement:

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