LONG-TERM MEASUREMENTS OF FOREST HYDROLOGY IN THE BESKYDY MTS.

M. Bíba, Z. Oceánská, Z. Vícha, M. Jařabáč

Forestry and Game Management Research Institute, Jíloviště-Strnady, Czech Republik
oceanska@vulhm.cz

Main natural characteristics of the Beskydy Mts.

The Moravian-Silesian Beskydy Mts. belong to the external Carpathian range with 18°00´-18°30´E and 49°30´N in the hilly region. The average yearly temperatures fluctuate between 2.3-7.8° C, yearly sums of precipitations between 756-1781 mm, on average 1150 mm. The lenght of vegetation period is 95-157 days with 921-1 542 hours of sunshine. The climate is mild cold. The parent rock are resistant sandstone and minder resistant slate covered by clay-earth or brown soils with the tickness 0.5-1.0 m. The mountains lie between 350-1324 metres a.s.l. with average slope 30-50%. Till 1989 they were not protected against concentrated immissions blown predominantly from the Ostrava industrial agglomeration only 20-50 km far from here. This area has now 75% forest cover percentage with wood species composition 76.5% conifers (73.6% spruce) and 23.5% broadleaves (19.6% beech), middle age 63 years, average standing volume 317 $m^3 \cdot ha^{-1}$, yearly mountain logging 6.45 $m^3 \cdot ha^{-1}$. The roading is 24.5 $m^3 \cdot ha^{-1}$.

Data from two experimental watersheds

The forest hydrological measurements have been done in this area since 1954 using experimental watersheds called **Červík** (CE 1.85 km²) and **Malá Ráztoka** (MR 2.07 km²). Both were calibrated without cuttings between 1954-1965 but following cuttings of all wood by stripes most after 1976 during 20 years. The water regime in both watersheds is characterized by great natural variation of intermittend component changes, not every full described and understand, by statistical methods.

The CE watershed lies between 640-961 metres a.s.l. and is natural divided into two parts: the left part CE-A (0.882 km²) and the right part CE-B (0.843 km²). CE-A was intensively cut between 1966-1981 to 96% of its area and renewed predominantly with spruce species, CE-B was reserved till now having no cut. The MR watershed lies between 602-1084 metres a.s.l. and wasn´t protected against immissions, and was between 1976-1987 cut in harmony with the research purpose – originally 35.8% of beeech species was fully renewed by spruce stand composition. Meteorological and hydrological data were carefully measured and used to calculate the water balance in both experimental watersheds and to evaluate them likely changes by forestry activities researched – we can publish here only a few of measured data:

Yearly sum of precipitations in CE was in CE on average 1124.9 mm and fluctuated ± 30%. Regional rainfall on 3rd-9th July 1997 summed 352.0 mm and the highest daily sum was at 18th July 1970 149.0 mm. In CE there are on average yearly 180 days without any rain, but we registered 5 daily rains > 100 mm. Average yearly temperatures were from 4.6°C to 8.2°C, on average 6.5°C. The total height of snow in winter was 135-515 cm, on average 400 cm. Substantial part of snow melted in winter. On the MR watershed the yearly sums of precipitations was 1 242.8 mm, from 841.9 mm to 1 780.8 mm. The highest regional rain was from 3rd to 9th July 1997 490.9 mm, the daily sum of rain 199.0 mm on 6th July 1997. In MR there are 183 days without any rain, but 7 daily sums > 100 mm. Average yearly temperatures were from 5.6°C to 8.6°C, on average 6.8°C. The total height of snow ranged from 66 to 424 cm, on average 259 cm.

The water balance is influenced by fluctuating interception in tree crowns (percentually 1-33%) and evapotranspiration (220-691 mm). The stemflow was not great. Yearly sums of outflows in CE were from 361.0 mm to 971.8 mm and average specific discharges q_a from 11.4 $dm^3 \cdot s^{-1} \cdot km^{-2}$ to 30.8 $dm^3 \cdot s^{-1} \cdot km^{-2}$. Similarly on the MR it ranged from 519.2 mm to 1438.2 mm, yearly discharges q_a from 16.0 $dm^3 \cdot s^{-1} \cdot km^{-2}$ to 45.6 $dm^3 \cdot s^{-1} \cdot km^{-2}$. On CE the highest peak discharge q_{max}=2416.0 $dm^3 \cdot s^{-1} \cdot km^{-2}$ (1 August 1971) and on MR q_{max}=3256.0 $dm^3 \cdot s^{-1} \cdot km^{-2}$ (25. July 1966). The minimum daily discharges were in CE q_{min} = 0.62 $dm^3 \cdot s^{-1} \cdot km^{-2}$ (3-4 December 1959) and in MRq_{min} = 0.92 $dm^3 \cdot s^{-1} \cdot km^{-2}$ (20 days). Average yearly discharge between 1954 and 2007 was in CEq_a= 20.5 $dm^3 \cdot s^{-1} \cdot km^{-2}$ and in MR q_a = 28.9 $dm^3 \cdot s^{-1} \cdot km^{-2}$.

Melting of snow always started only by climatic impulse, however, having no registered difference following an accelerated forest renewal in CR or MR. It has to be mentioned that formation of dangerous flood does not threaten this area in spring.

The measurement of erosion by water with transport of bedload and sediment has been carried out in both watersheds from 1958. It was found out that greater load has been transported only by flooding, however this does not occur very often. The sediment comes often after natural rill erosion which intensity was in MR three-times greater than in CE.

The main findings on the experimental CE and MR watersheds

At the beginning of this research it was expected that modificatiouns of outflows on small, forested, hilly watersheds will be easily proved by differences in water balance between calibration period and accelerated cut of woods and renewal of this with optimum of its stand composition. We have learned that it wasn´t possible to find any changes by the help of equation of water balance. Relationships are complicated in the subsystem and not easily provable. It is necessary to evaluate sufficiently long-time series of data to obtain truthful results. Phenomena with short duration (discharge waves) have to be measured already per minute but in long-time series because of their rare repetition. It is needed to differentiate strongly the consequences between felling with immediate renewal of forests from the full deforestation of area because of more important ecological effects.

We know that the renewed forests in both experimental watersheds are 20-40 years old now. This forestry experiment brought only a small presentation of the precipitation – outflow regime and the expected changes of water regime were not proved. The forests and the low vegetation are consuming water at every time but they retain beneficial quality and quantity of water. We haven´t paid sufficient attention to the water regime of forest soils. Their good functions are connected not only with the abundance of organism, but also with the functions in the water cycle.

Results of the long-term forest-hydrological research in CE and MR were thought as a proposal for forest management to respect their functions in the water cycle. But all data and results may be only significantly transfered into other areas with local respects.

The ecosystem in forested watersheds should be operated following its own principles to sustain the existence of the renewing without any disturbing impulses and relations. We cannot disrupt dynamics of the nature by any political or economical interests or rules of mankind. We have learned that the results of investigation are from time to time deformed by orders or leading authorities too. Our duty is to bring new experiences into consciousness of people and political ideas. The knowledge, experience and design of necessary measures without any encouragements cannot bring any beneficial effect.

Figure 1. Aerial view of the Červík watershed (Photo: Jan Vondra, September 2005)

Figure 2. Aerial view of the Malá Ráztoka watershed (Photo: Jan Vondra, September 2005)

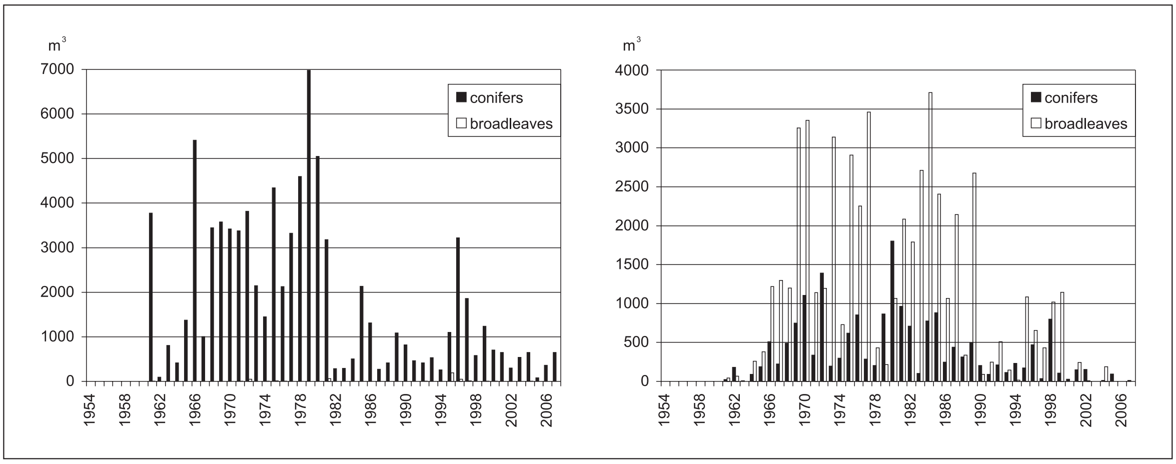

Figure 3. Yearly volumes of felling (m³) in the Červík (left) and Malá Ráztoka (right) watershed

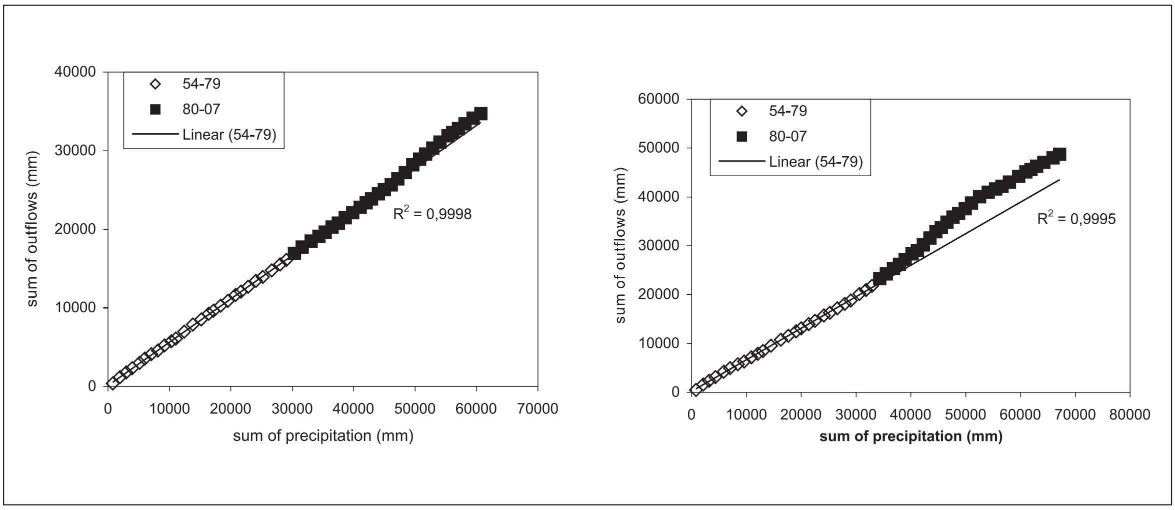

Figure 4. Double mass curve in the Červík (left) and Malá Ráztoka (right) watershed

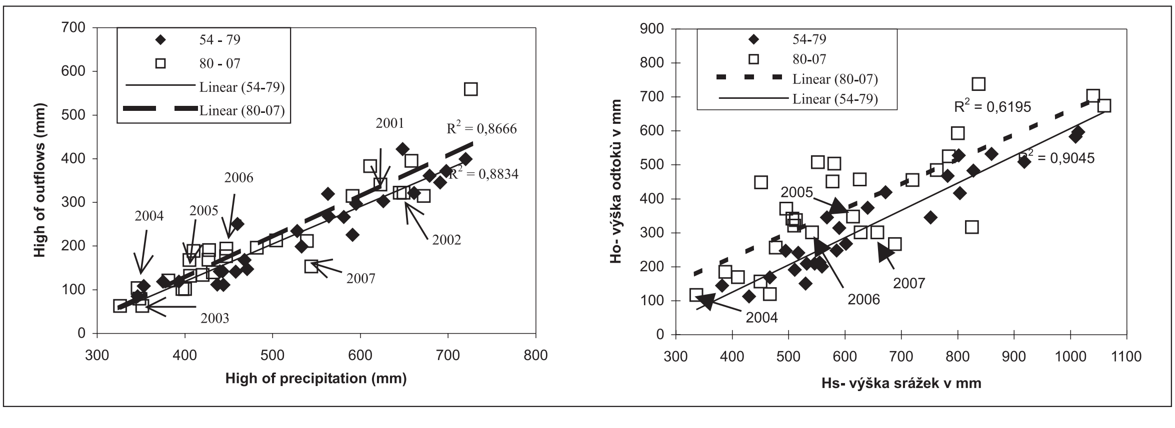

Figure 5. Example of dependence of outflows in rainfalls during warm periods (VI – X) between 1954–1979 and 1980–2007 years in the Červík (left) and Malá Ráztoka (right) watershed