

Hydrology of the High Tatra Mountains

Influence of the windfall in November 2004 on hydrological regime of the upper Poprad river



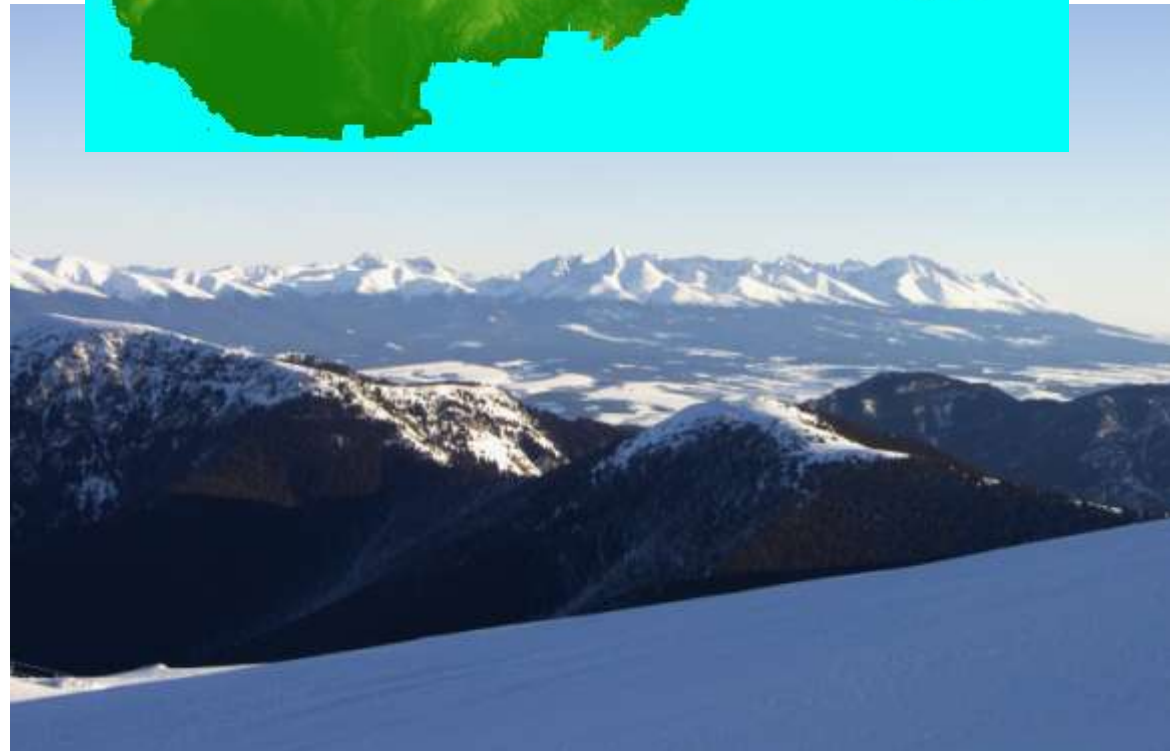
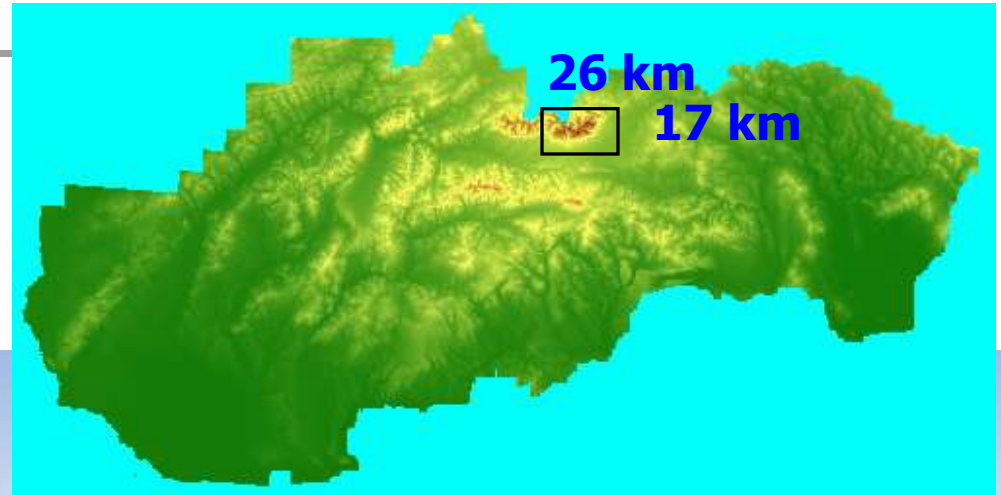
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¹Institute of Hydrology, Slovak Academy of Sciences

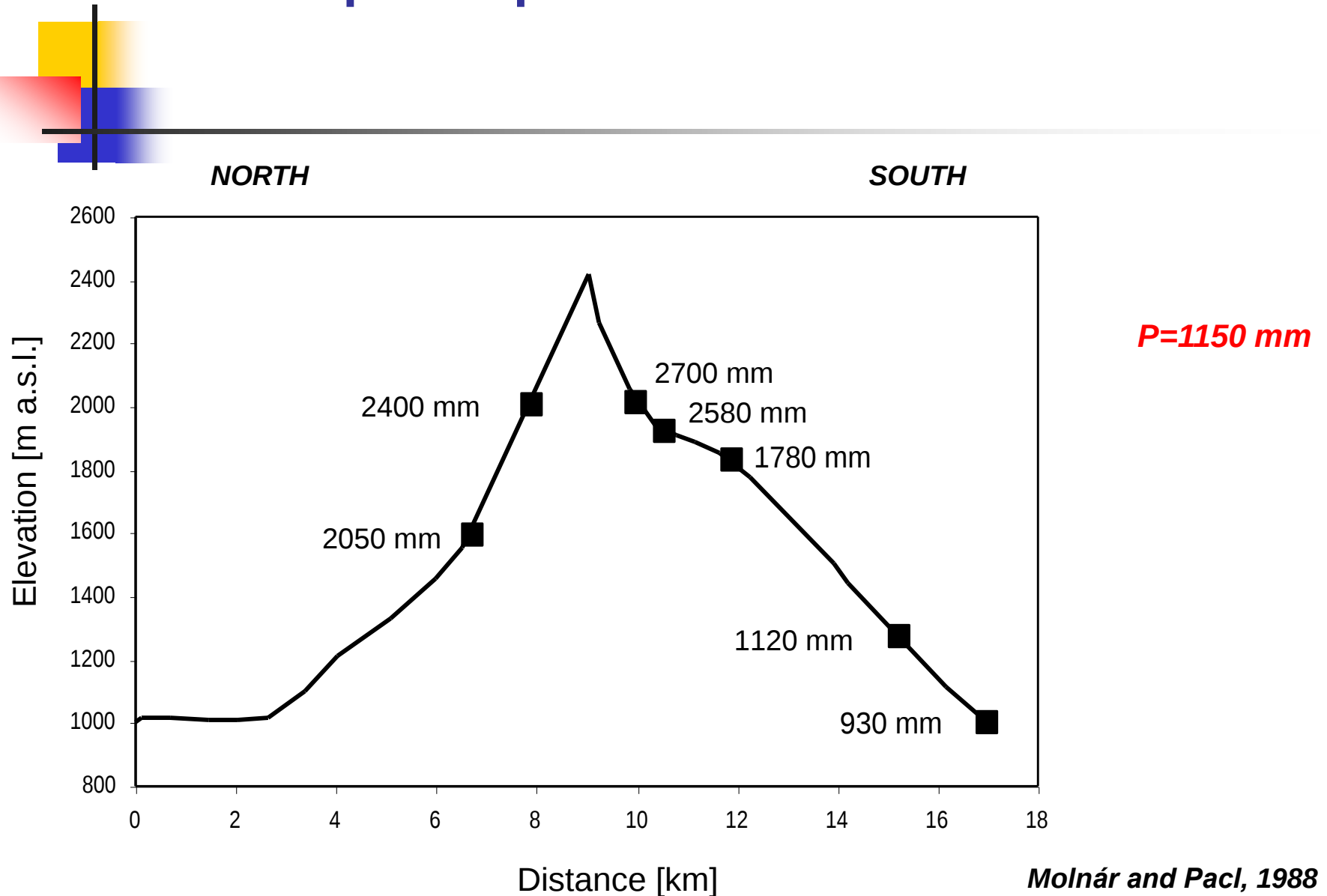
²Slovak Hydrometeorological Institute

Štrbské Pleso, 8 April 2010

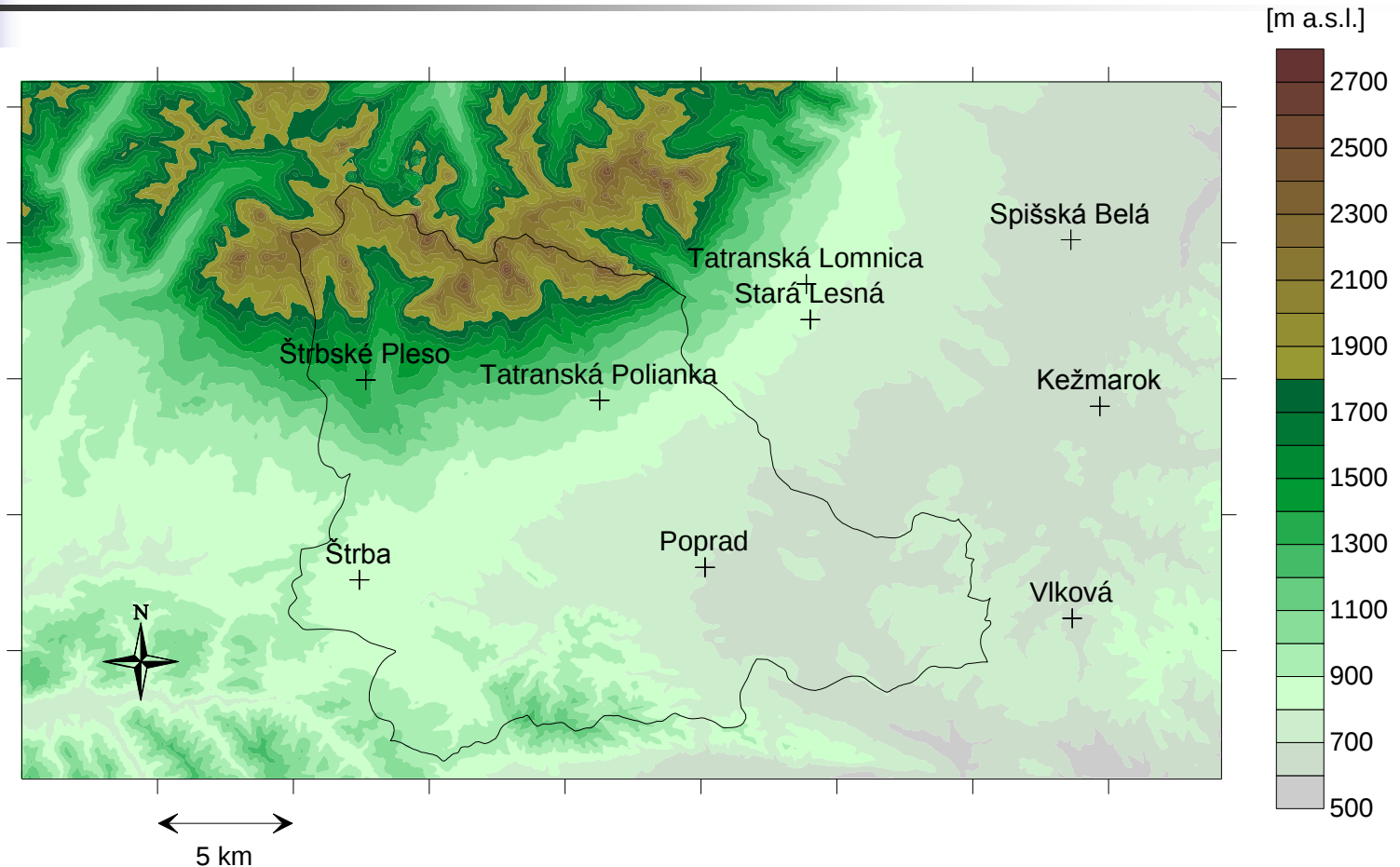
The High Tatra Mts. (341 km^2)– the highest part of the Carpathians (241000 km^2)



Annual precipitation – altitude effect

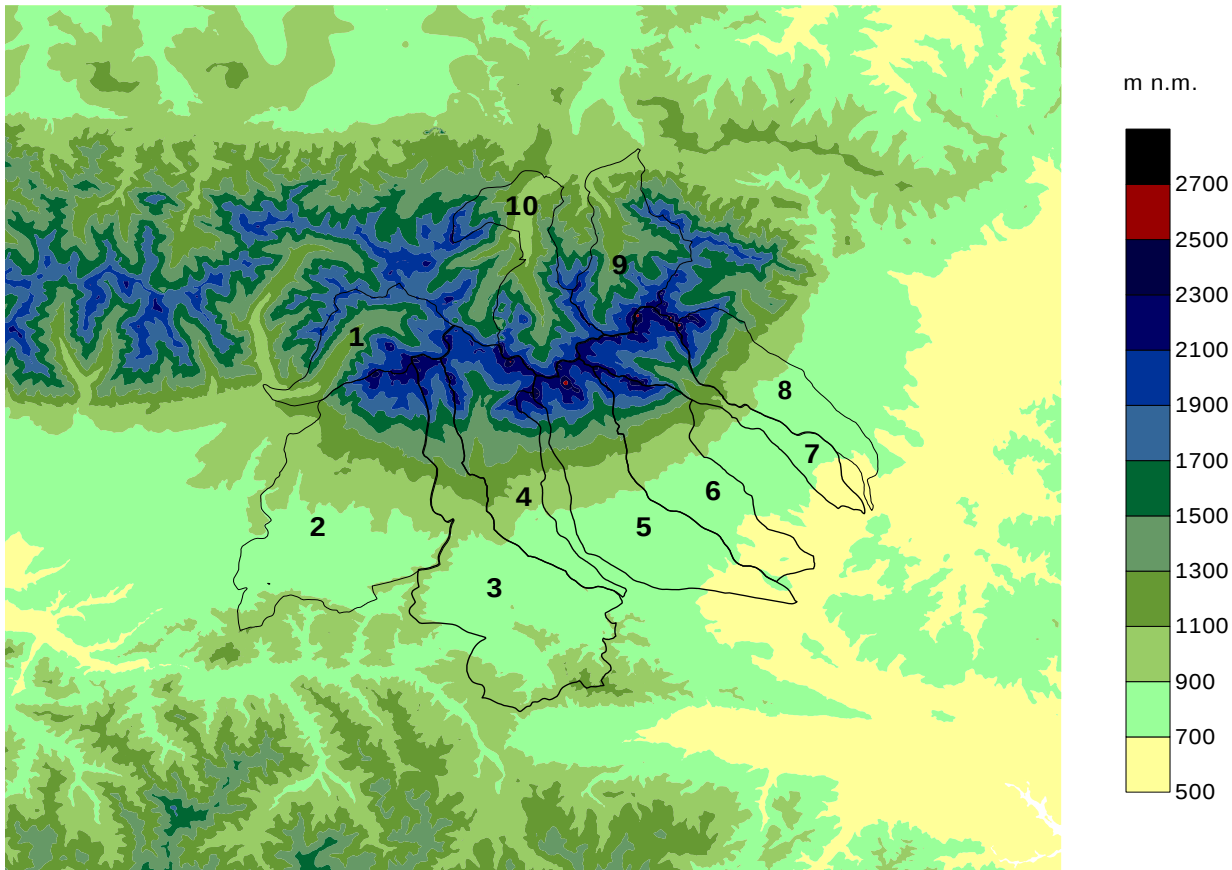


Upper Poprad river catchment

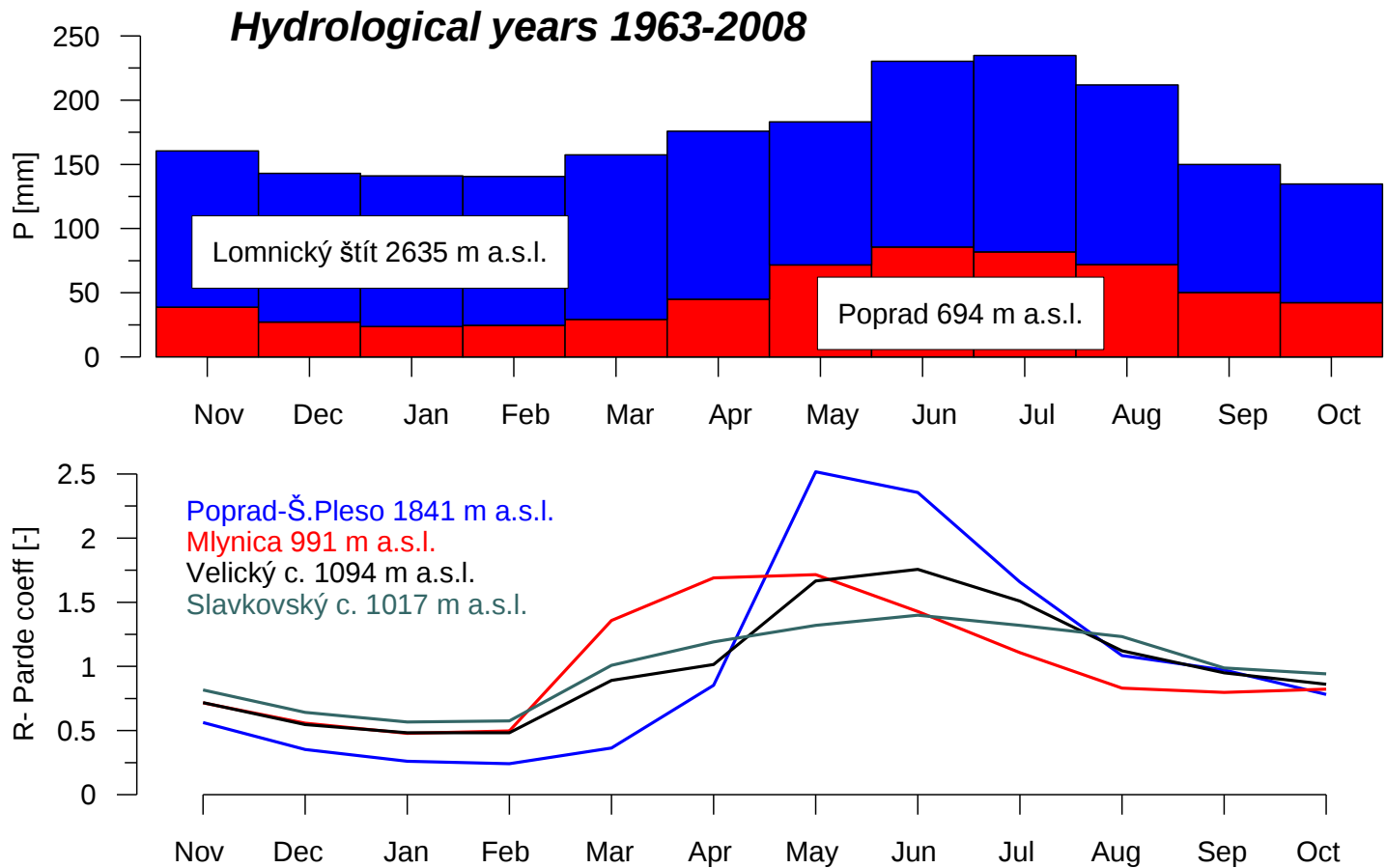


Runoff coefficient = 0.7 (0.5-0.9)

Upper Poprad river subcatchments



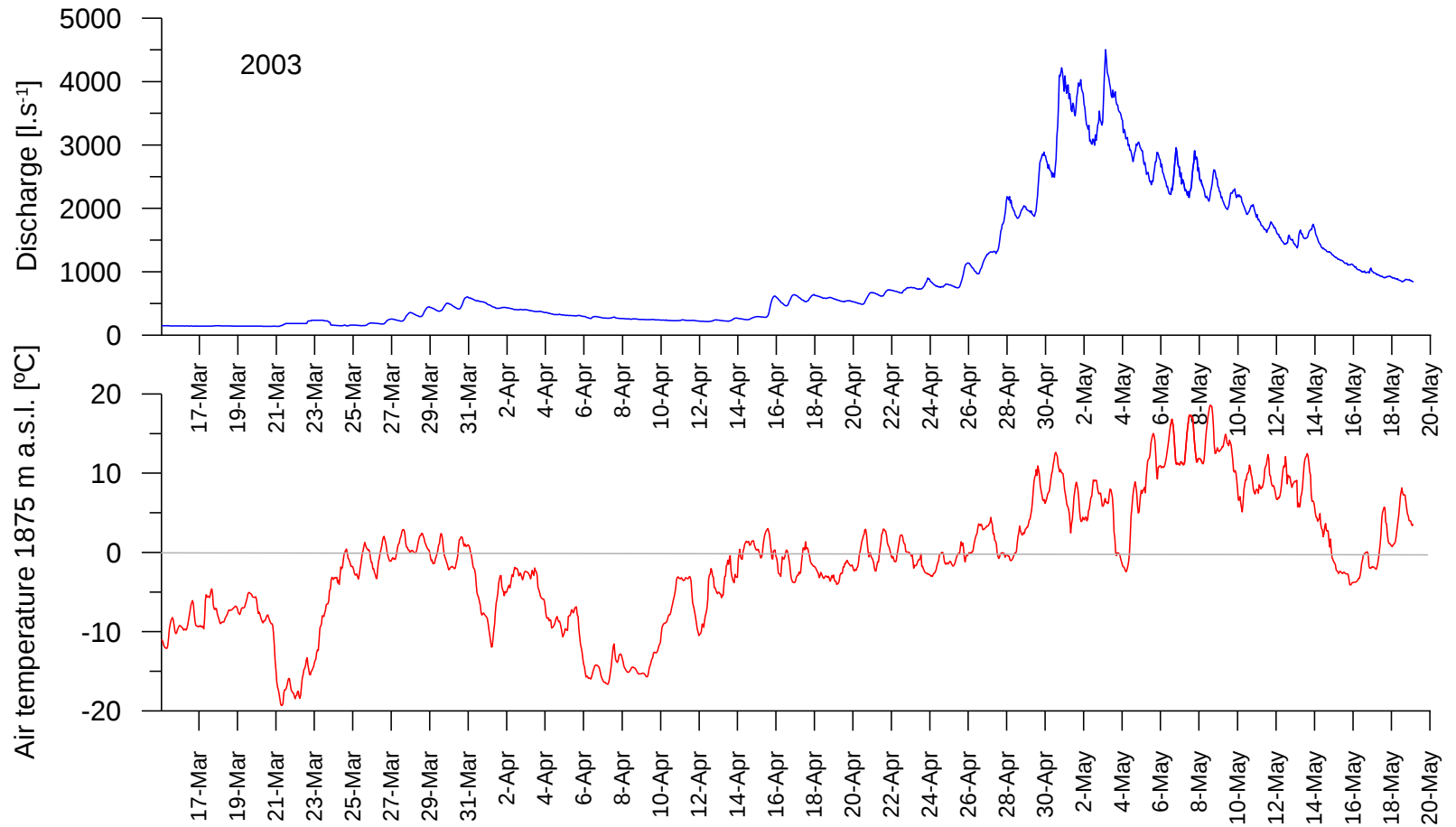
Seasonal precipitation, runoff



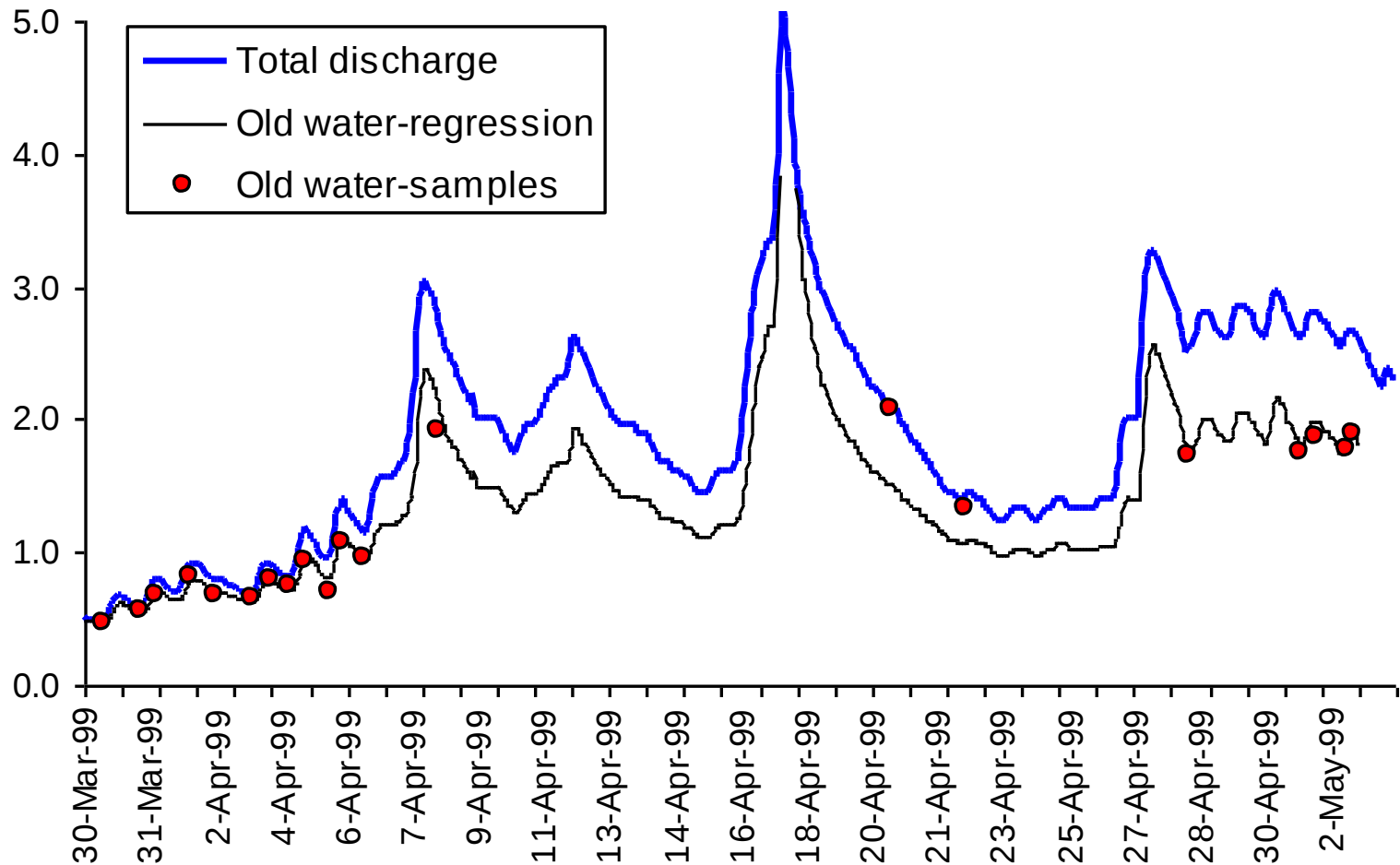
Snow cover



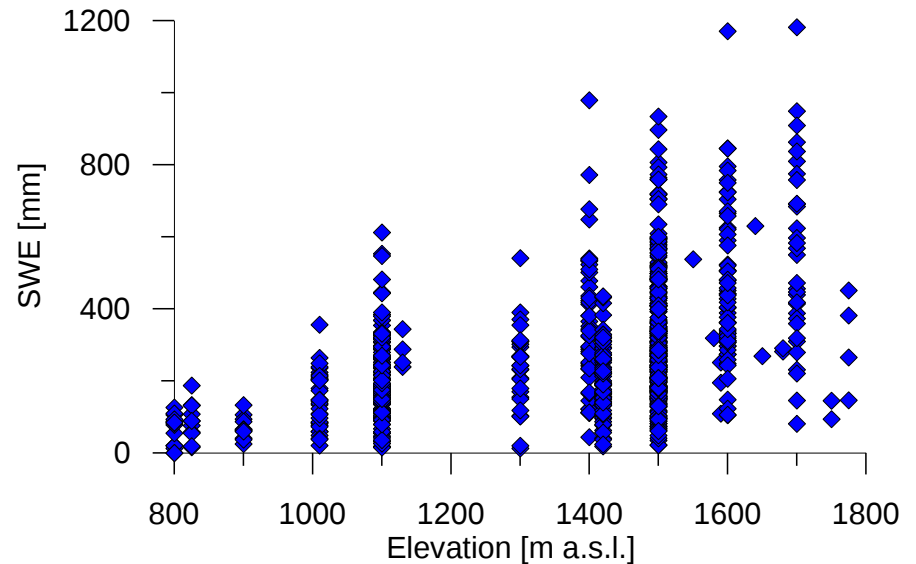
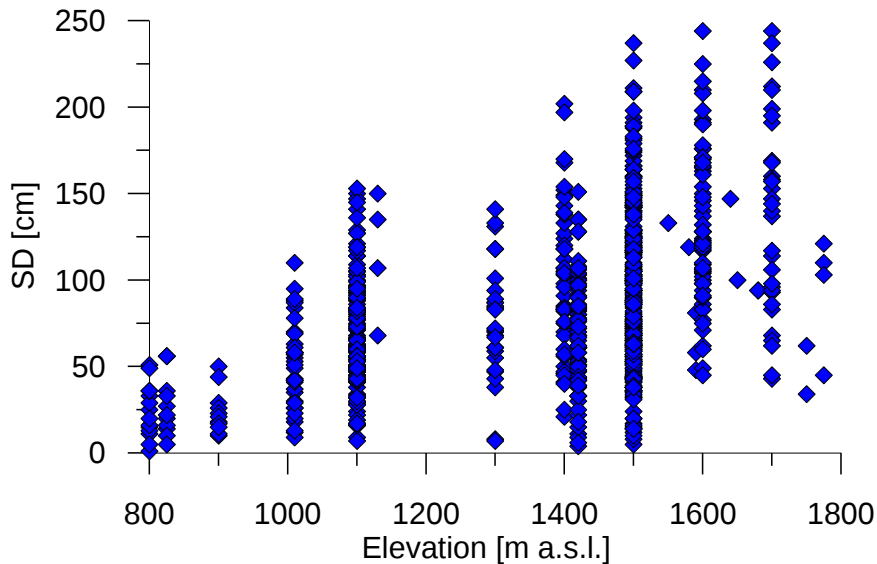
Snow cover



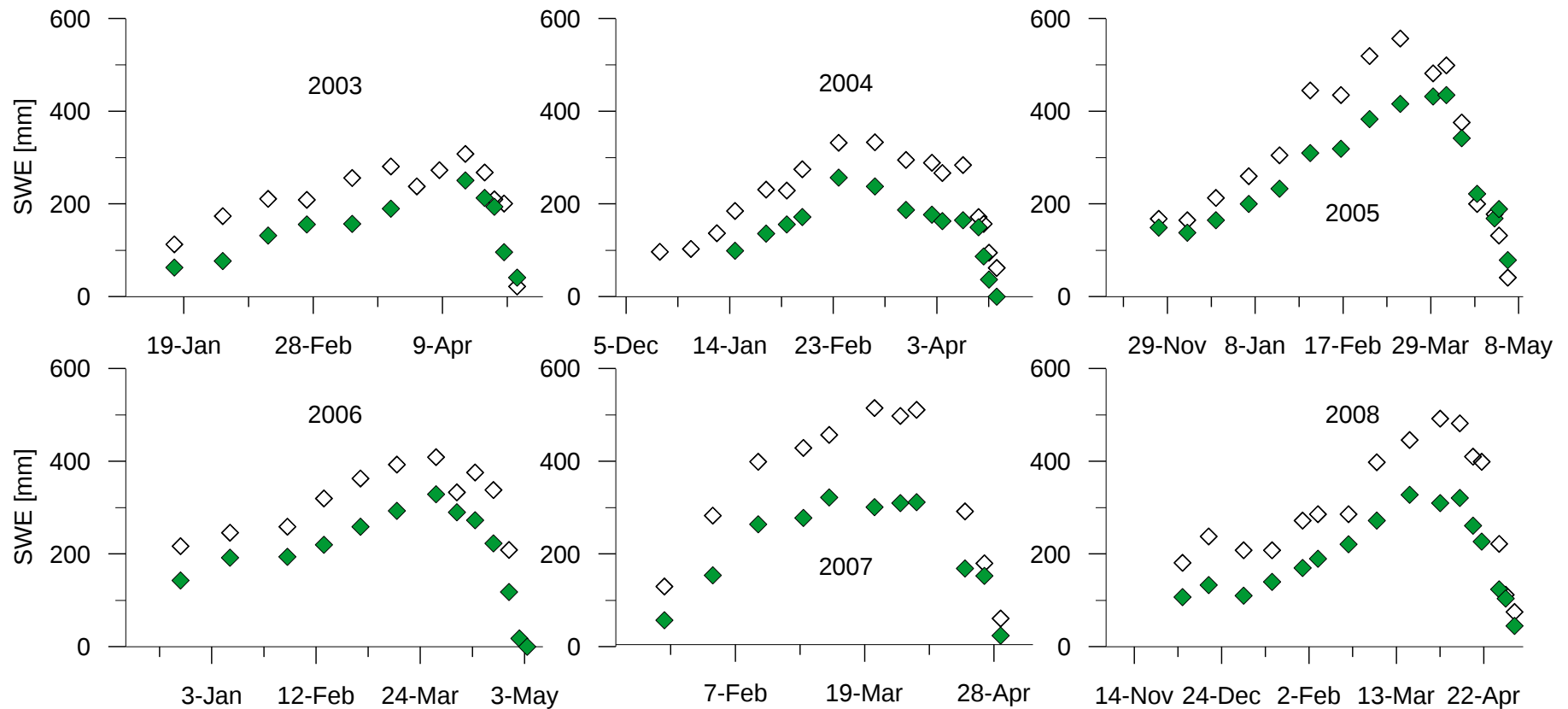
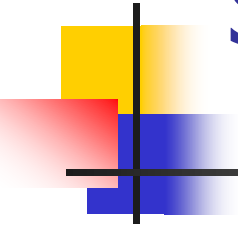
Importance of the snow cover



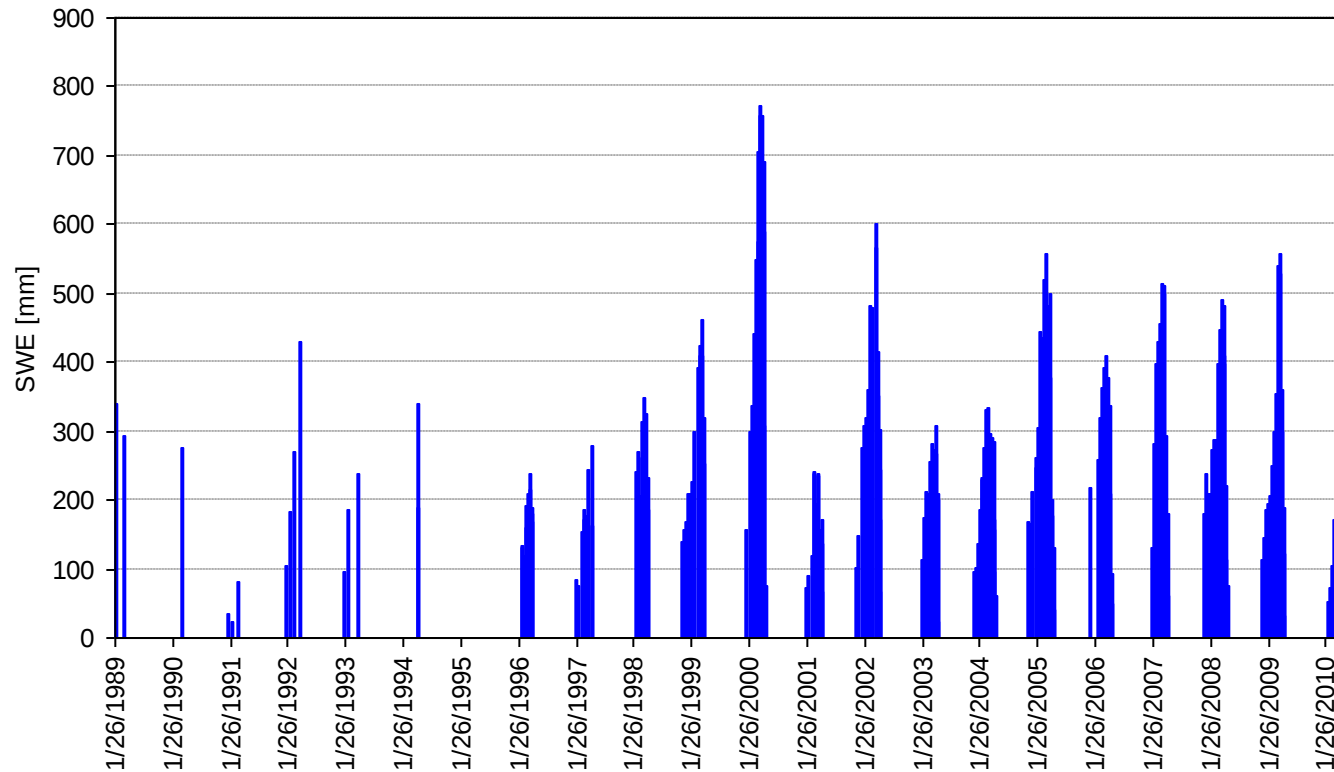
Snow cover – altitude gradients



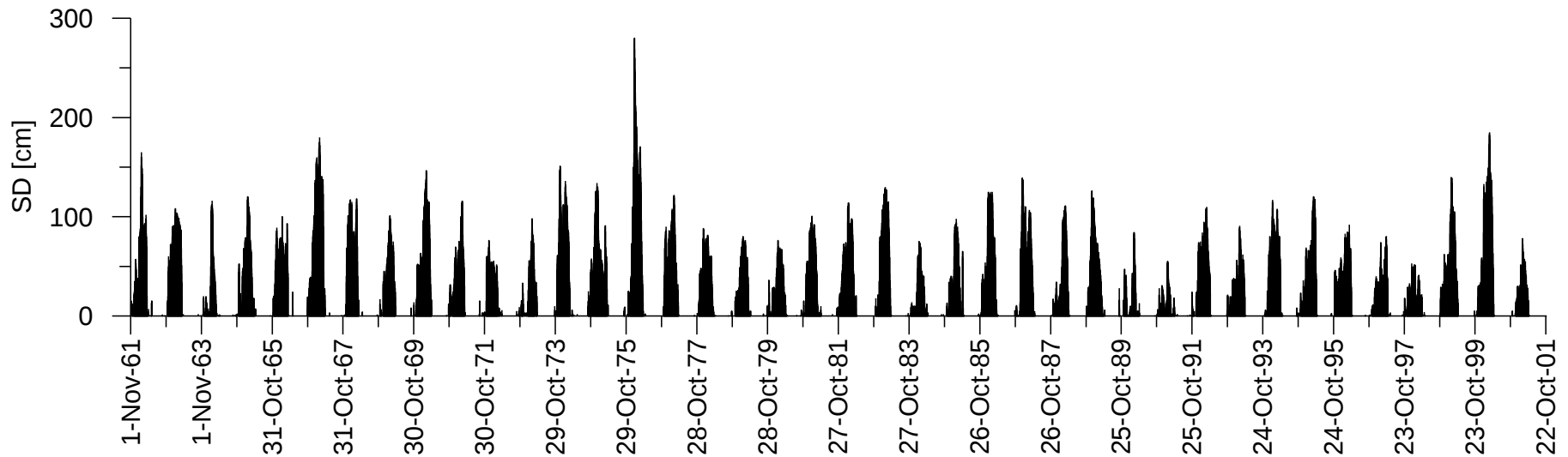
Snow cover – forest/open area



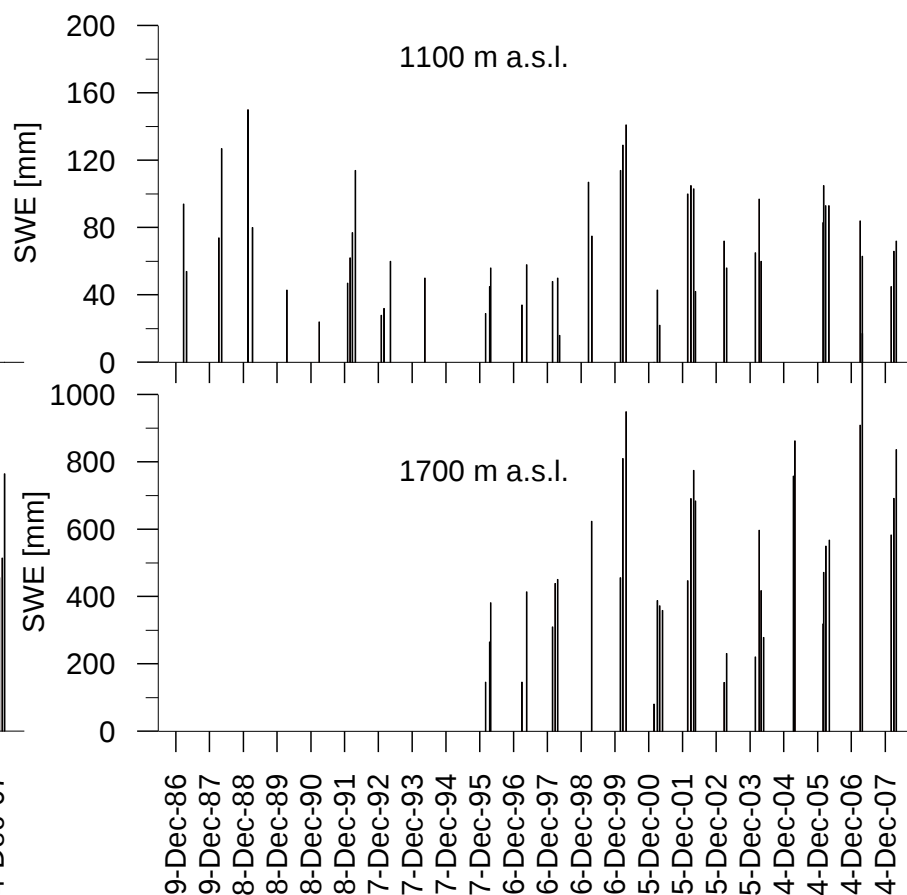
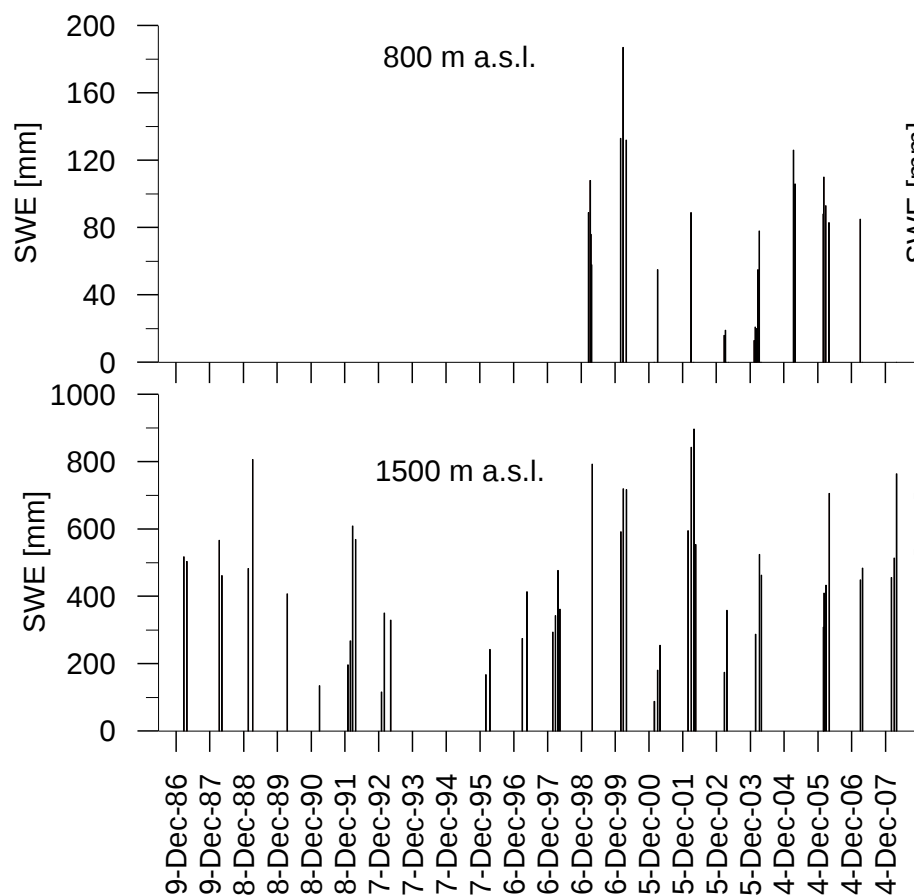
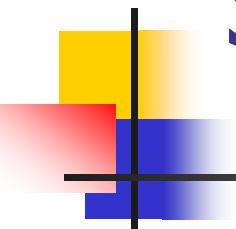
Snow cover – this winter



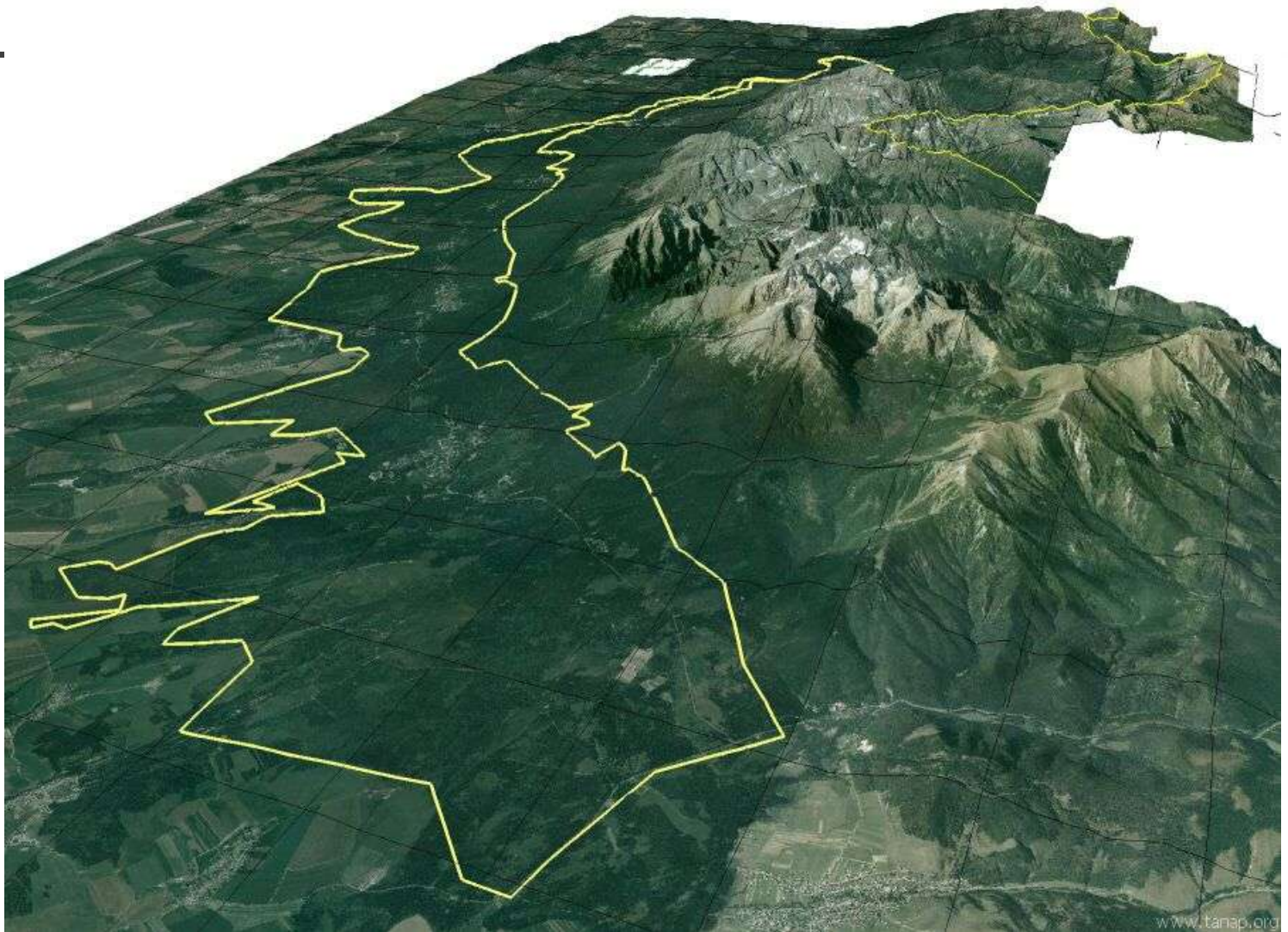
Snow cover – trends???



Snow cover – trends???



Windfall in November 2004

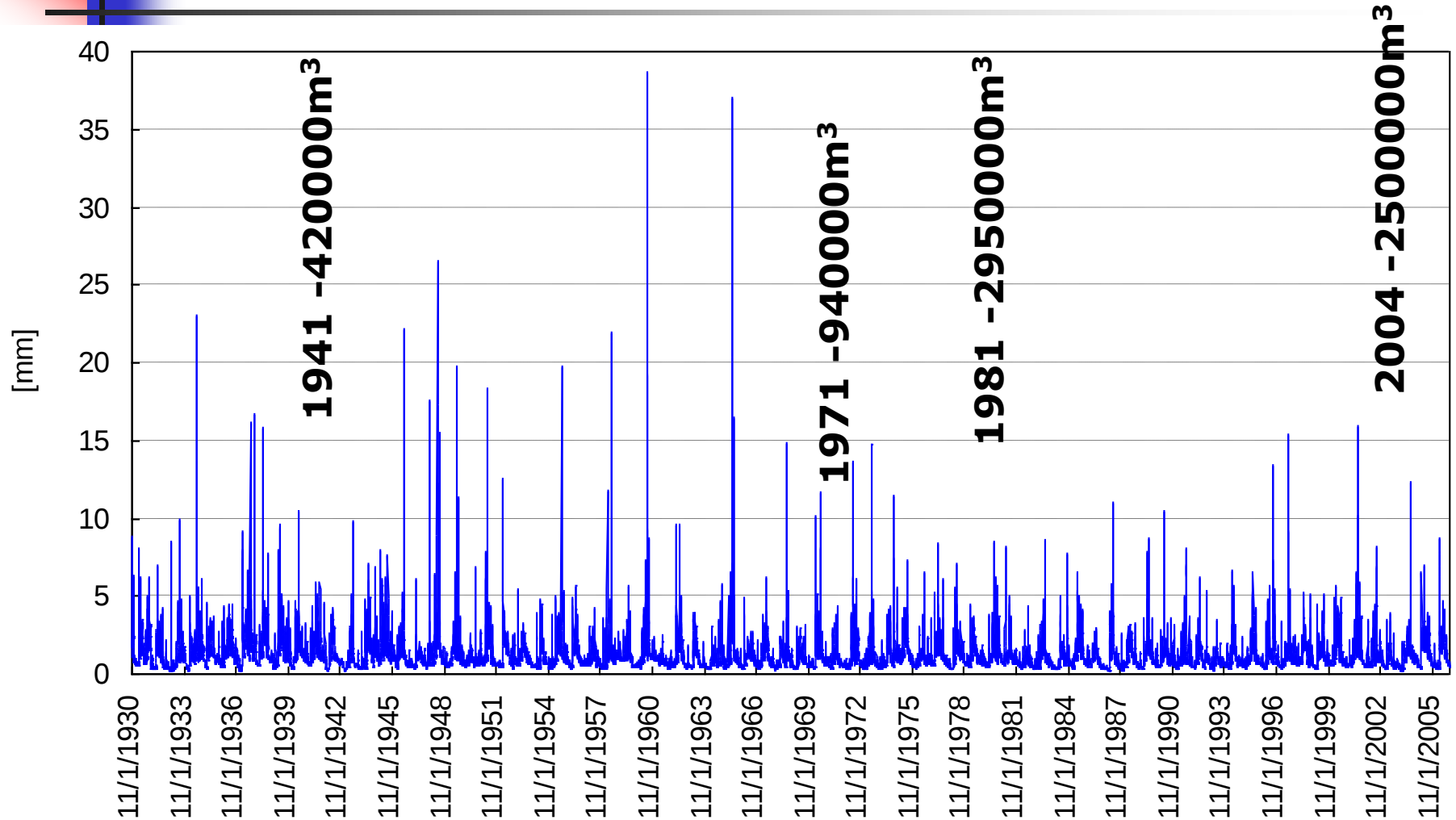


Questions

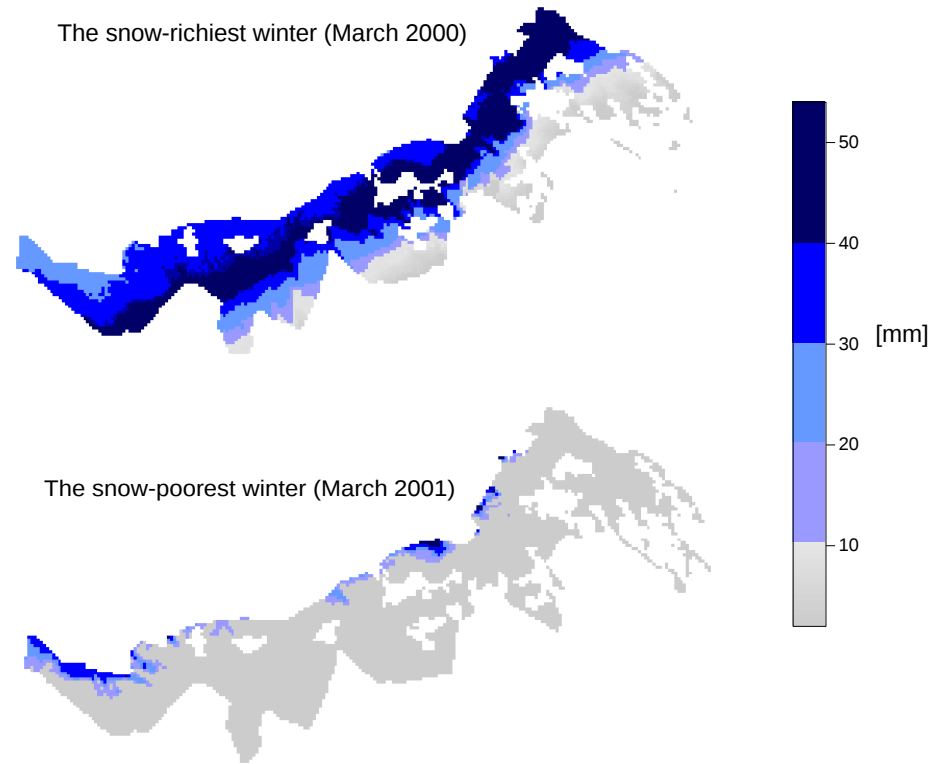
- Hydrological impacts of the windfall
- Increased flooding (high discharges)?



Discharges (Poprad river) and windfalls

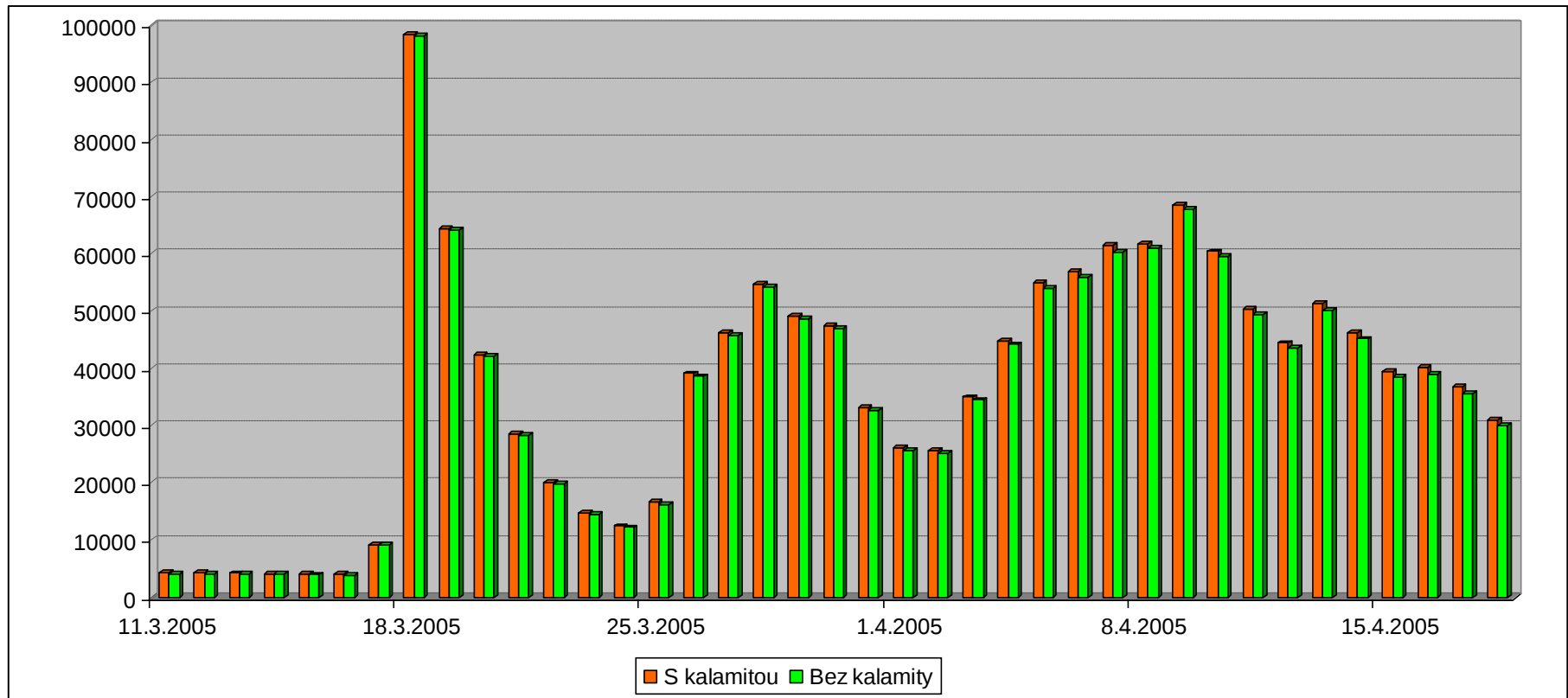


First analyses – snow accumulation and melt



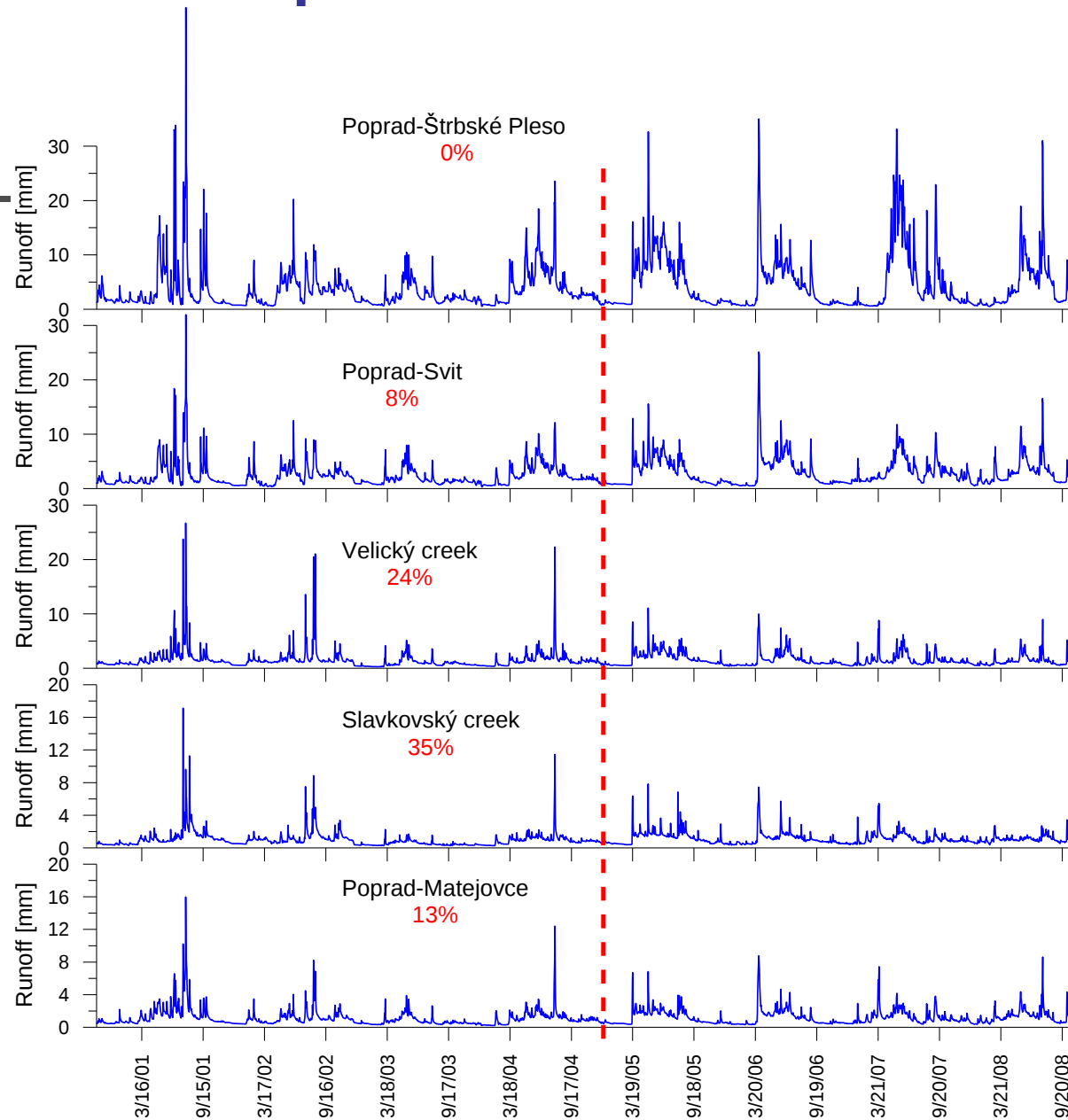
Mean SWE in March; the difference between original vegetation (forest) and grassland (Kostka et al. 2005)

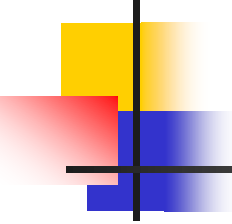
Simulated runoff (volume of water) for the elevation zone 800-1150 m a.s.l. ($\approx$ windfall area) before and after the windfall



Orange – destroyed forest green - original forest

Pre- and post-windfall discharges

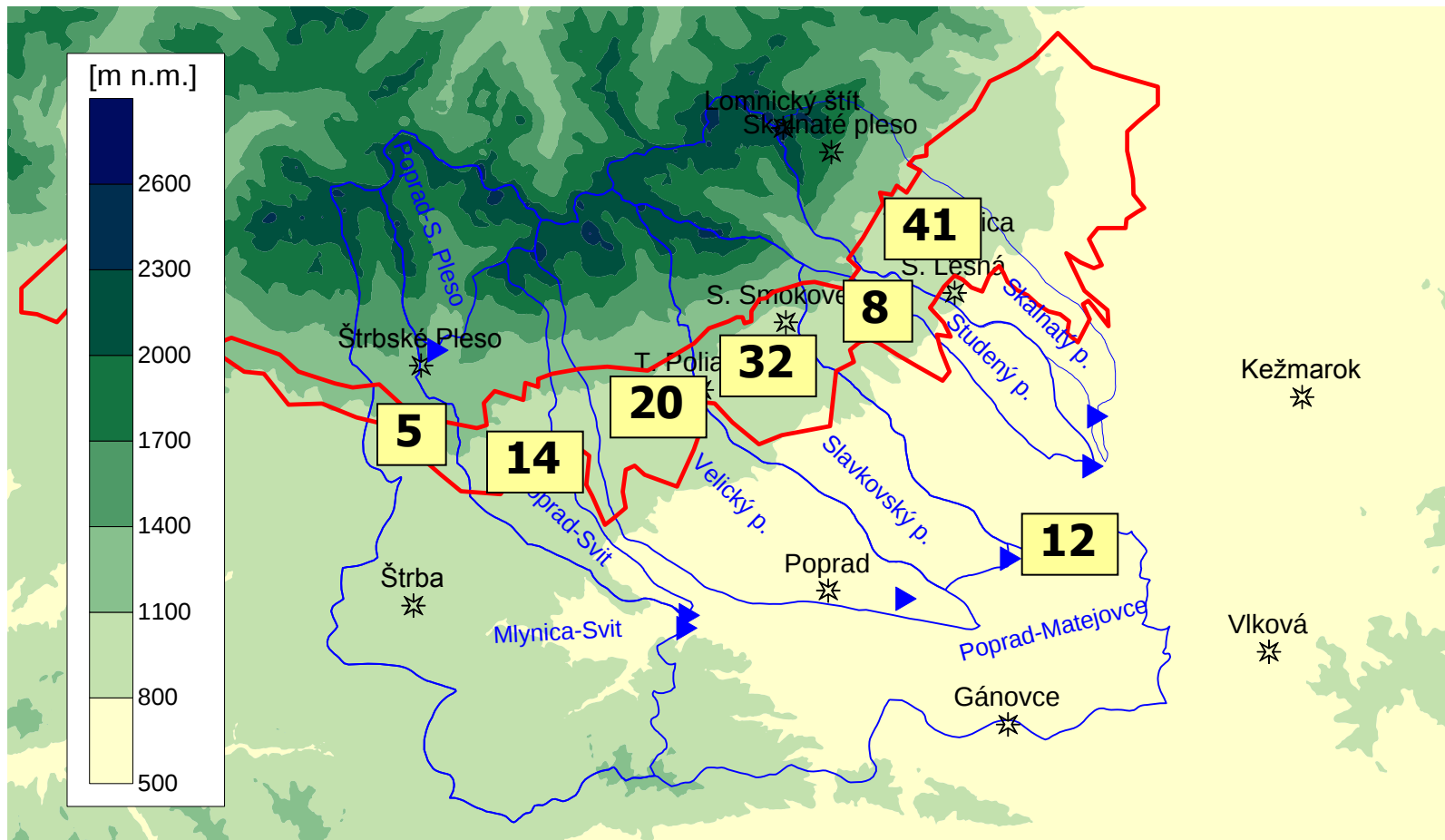




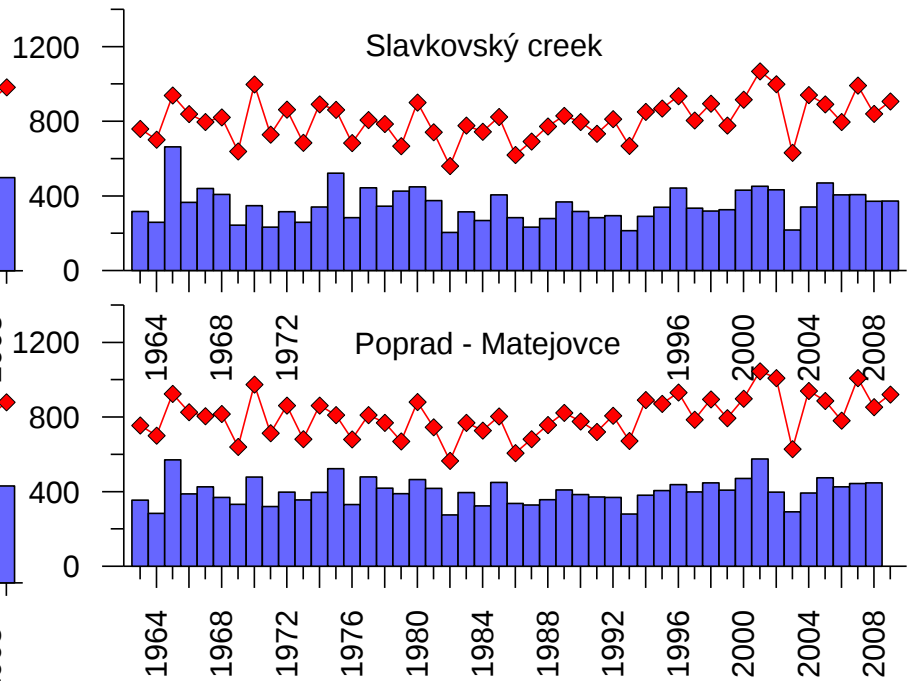
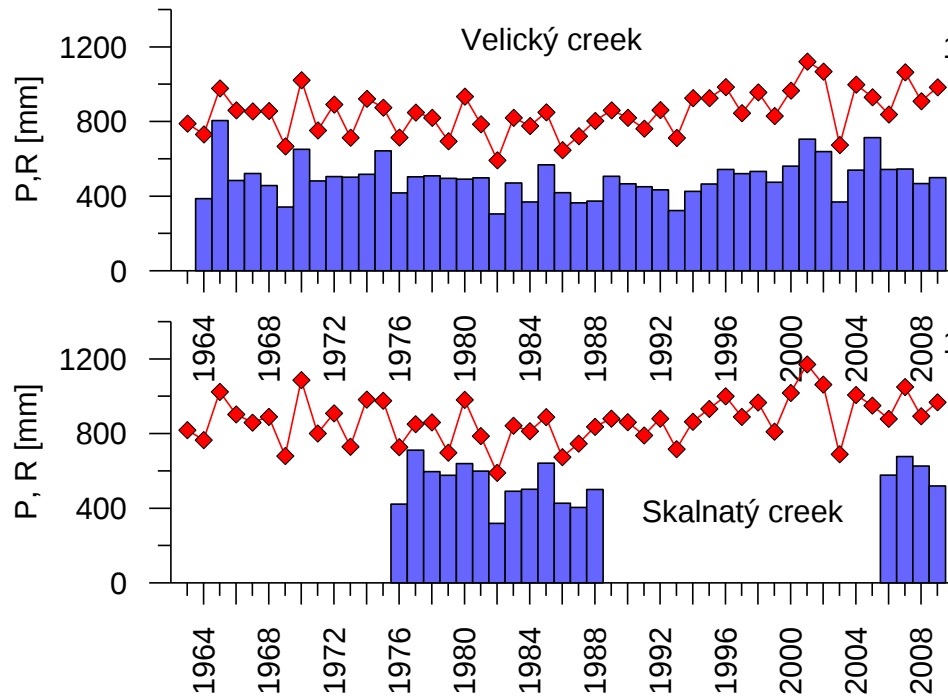
Analyses of historical rainfall-runoff data (since the 1960')

- Water balance, minimum and maximum runoff, runoff coefficients, runoff events, flashiness coefficients, baseflow (groundwater recharge), ...

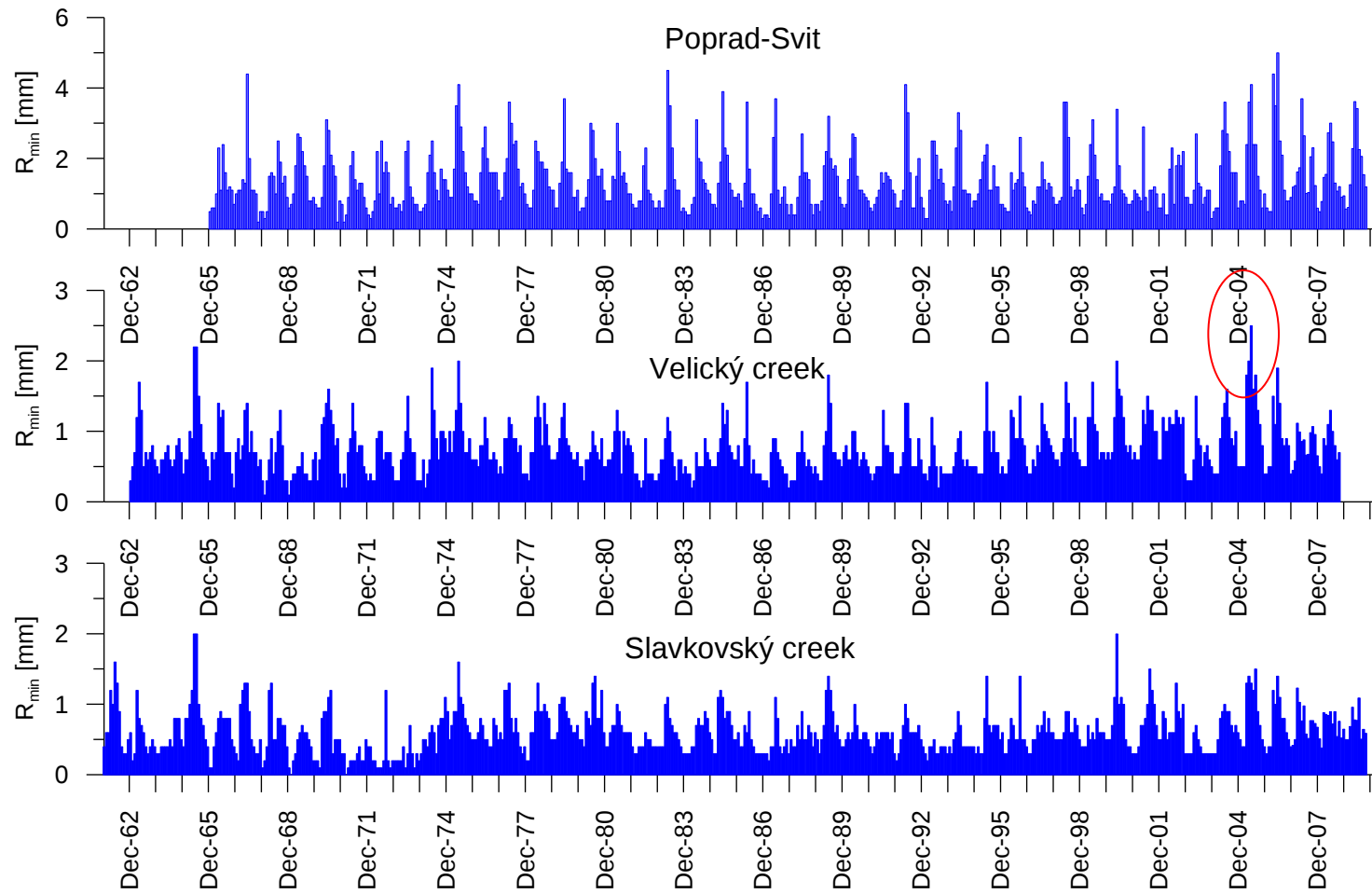
Subcatchments, precipitation stations, windfall area



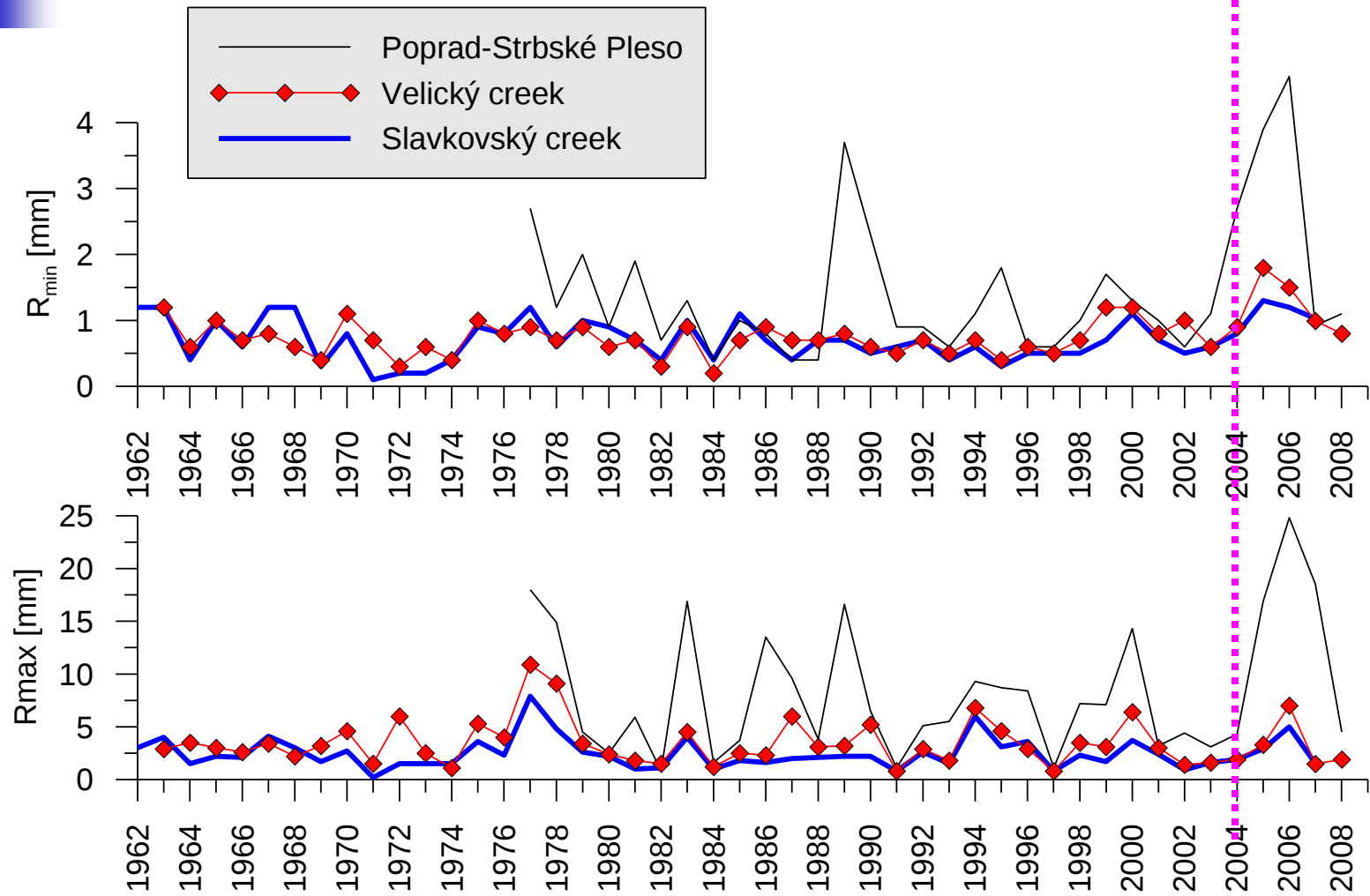
Annual precipitation and runoff



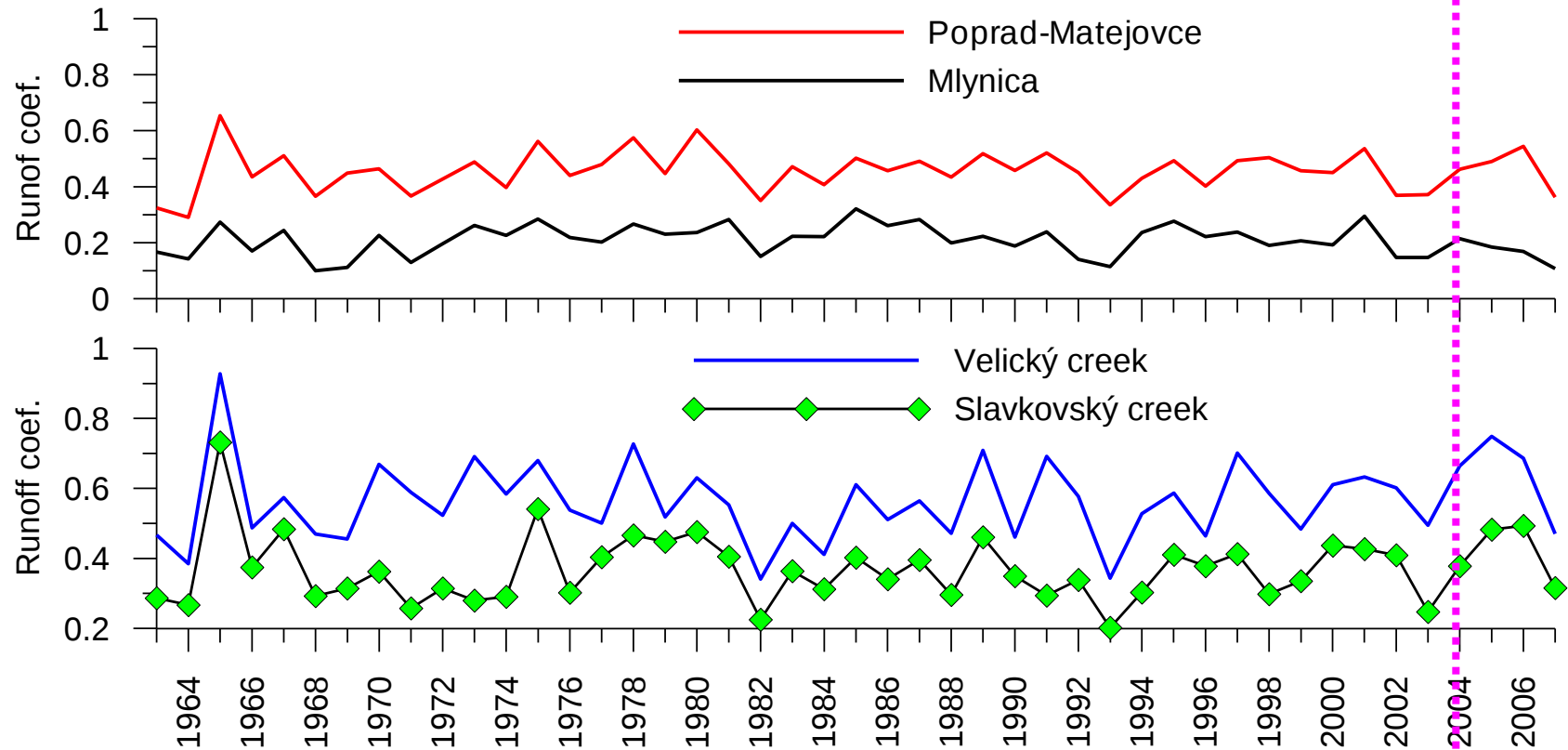
Runoff – monthly minima



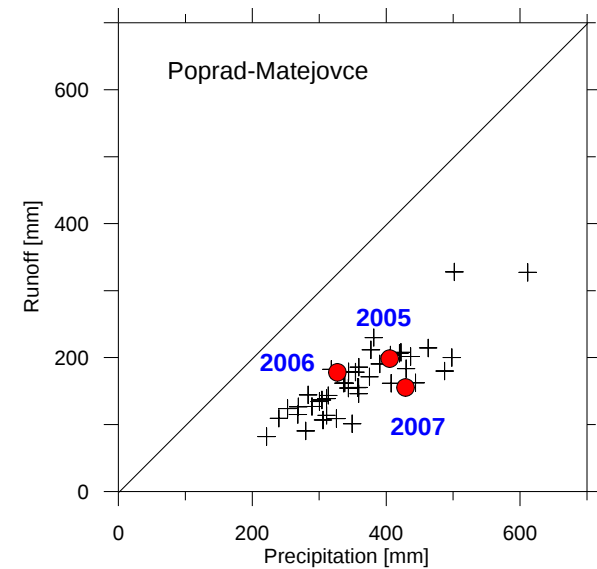
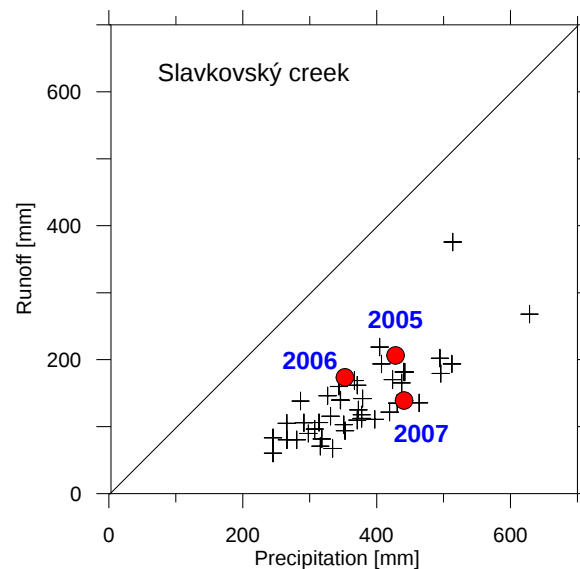
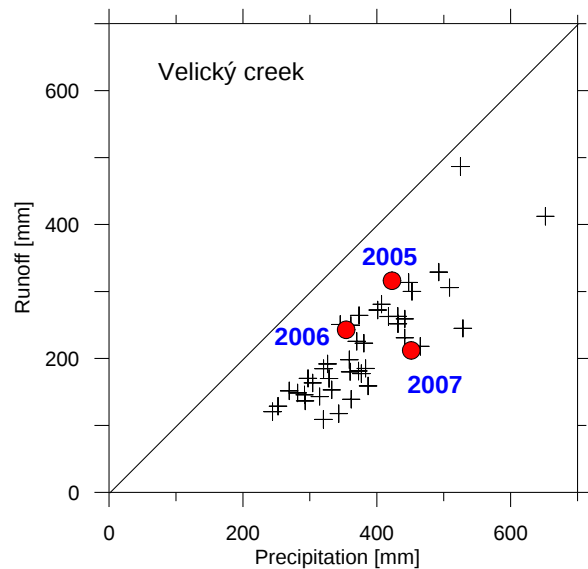
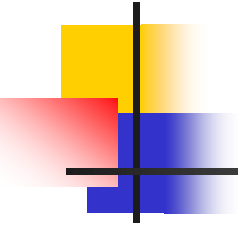
April – minimum and maximum daily runoff



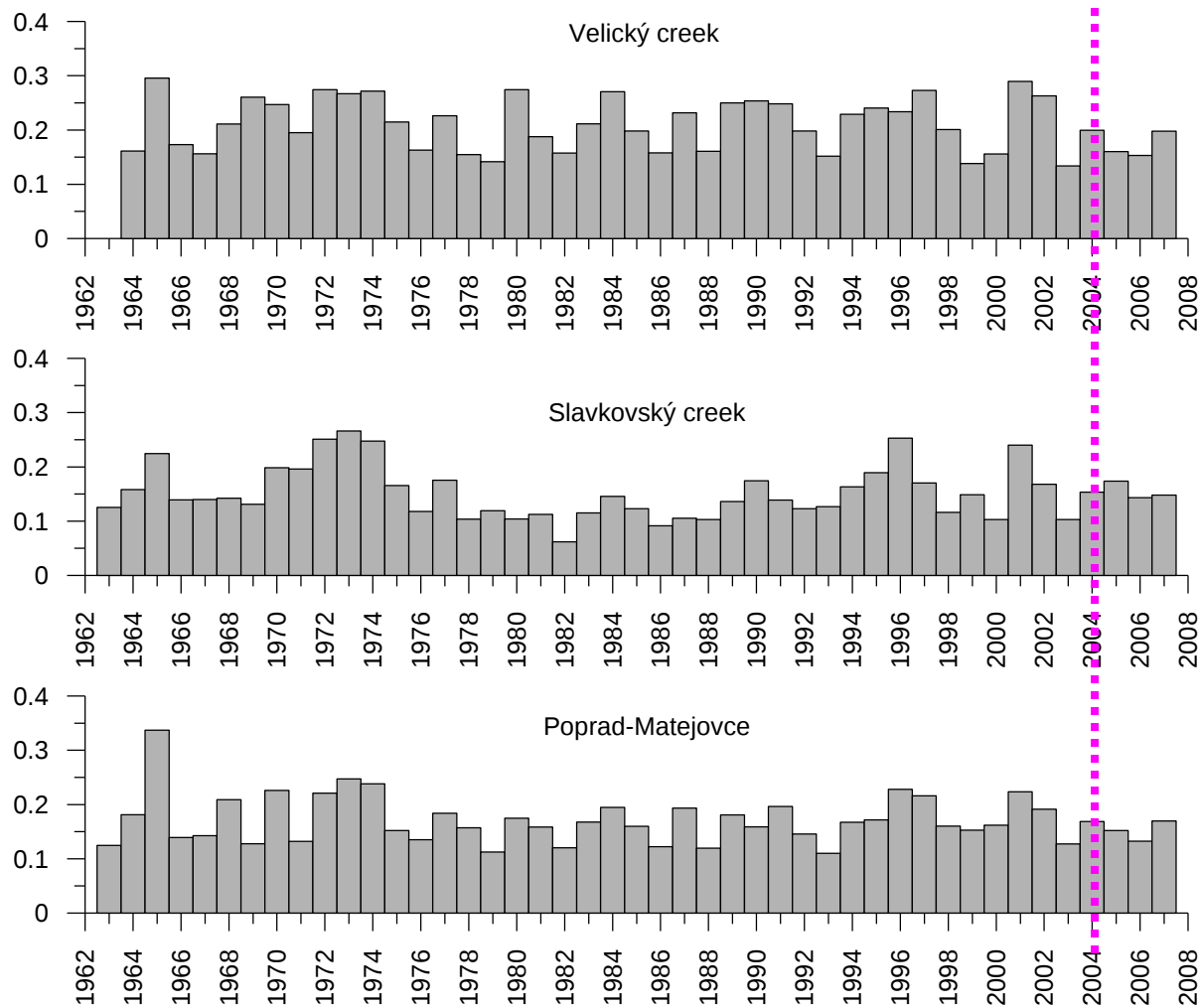
Runoff coefficients—the warm period of the year (June–September)



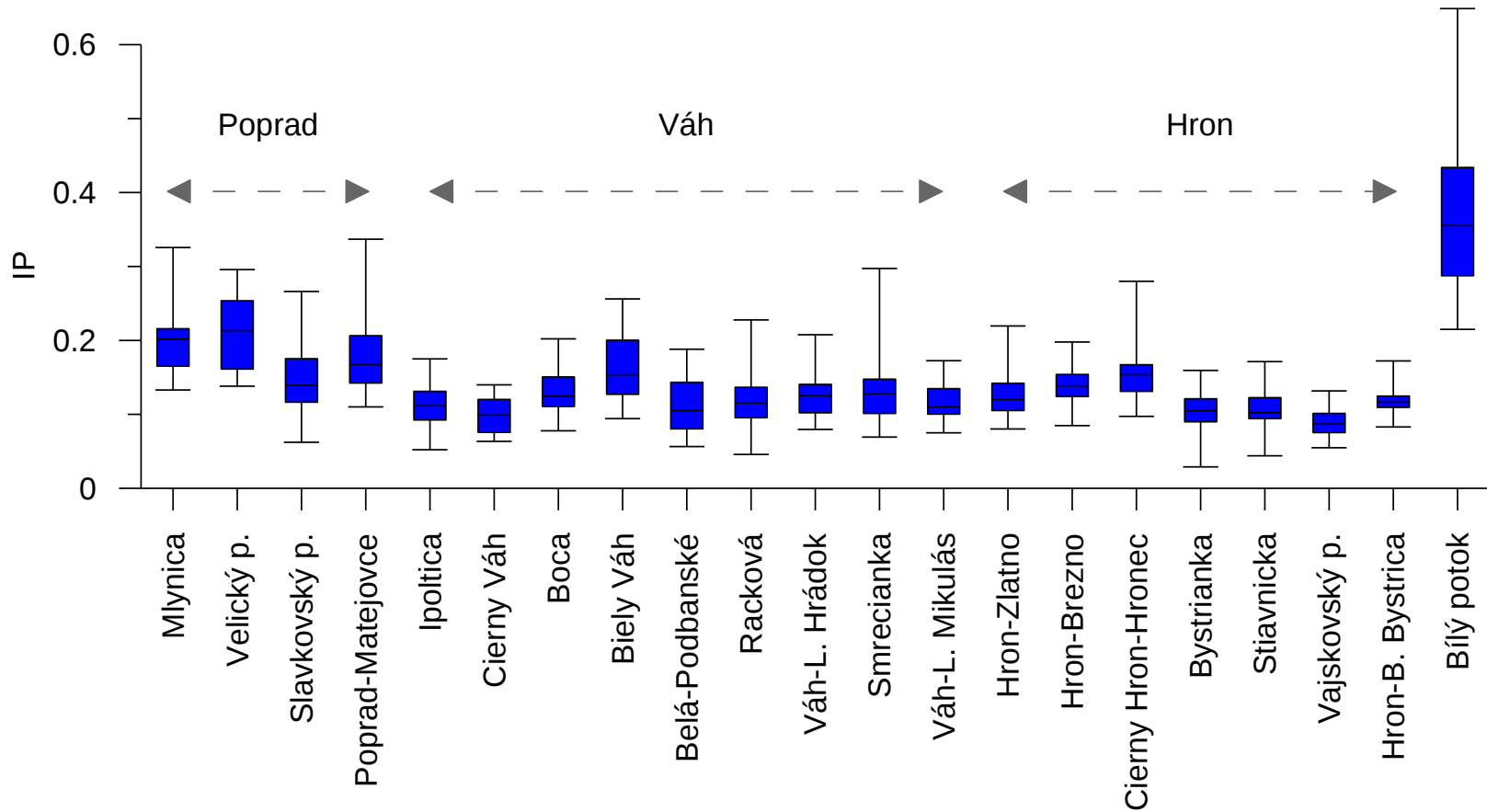
Rainfall-runoff correlations (warm period of the year)



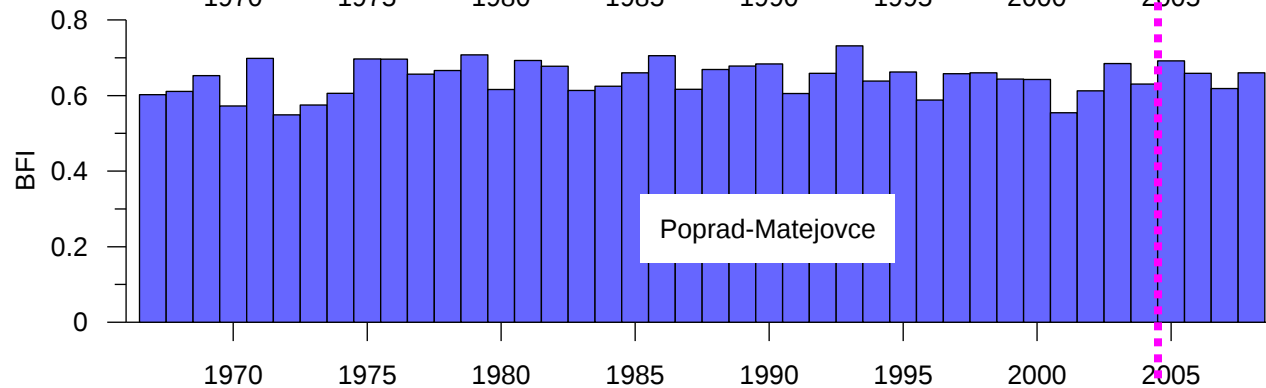
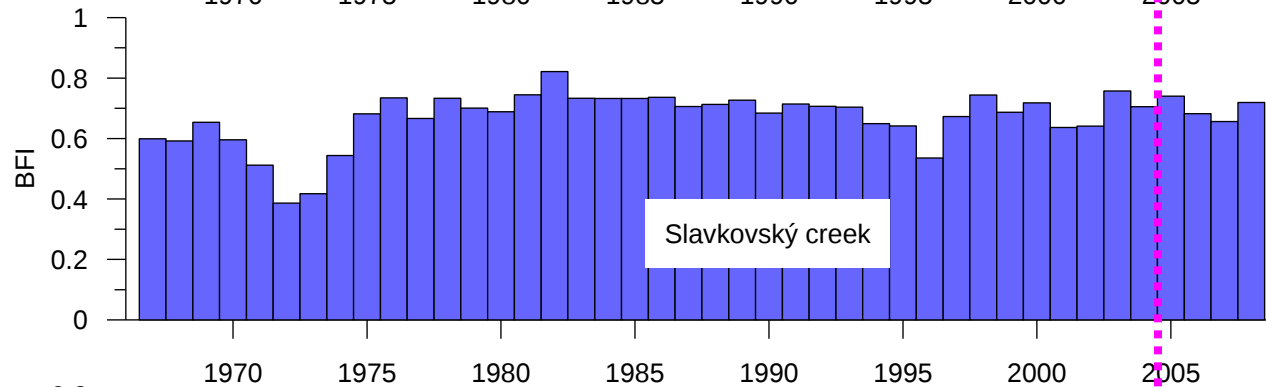
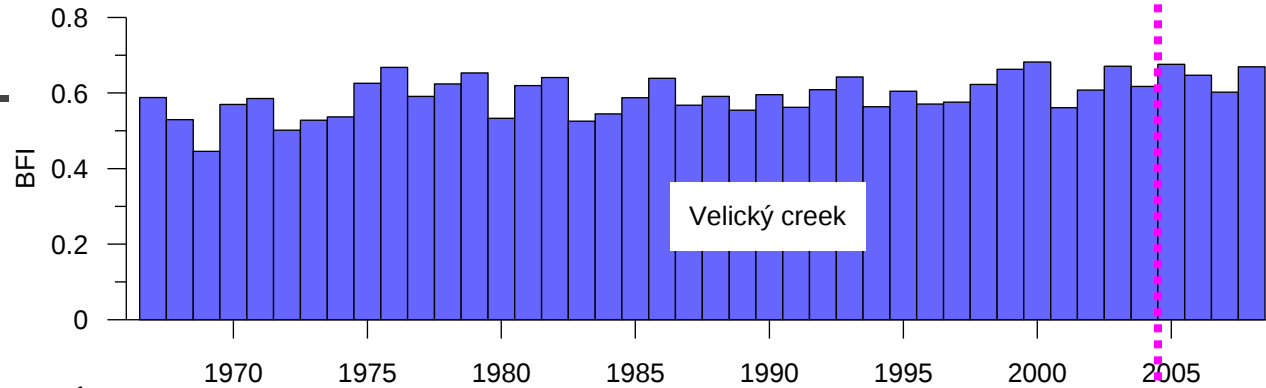
Flashiness index



Flashiness index for different rivers

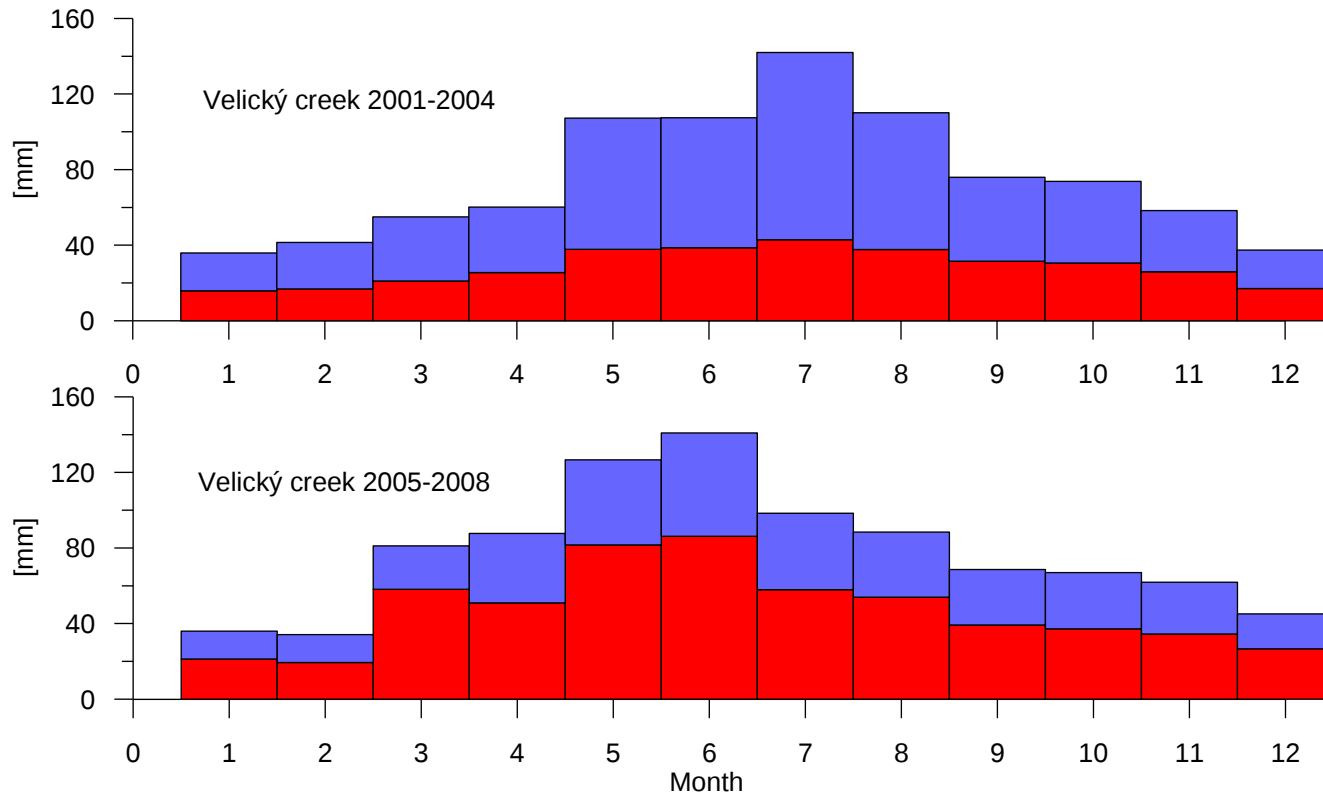


Baseflow index



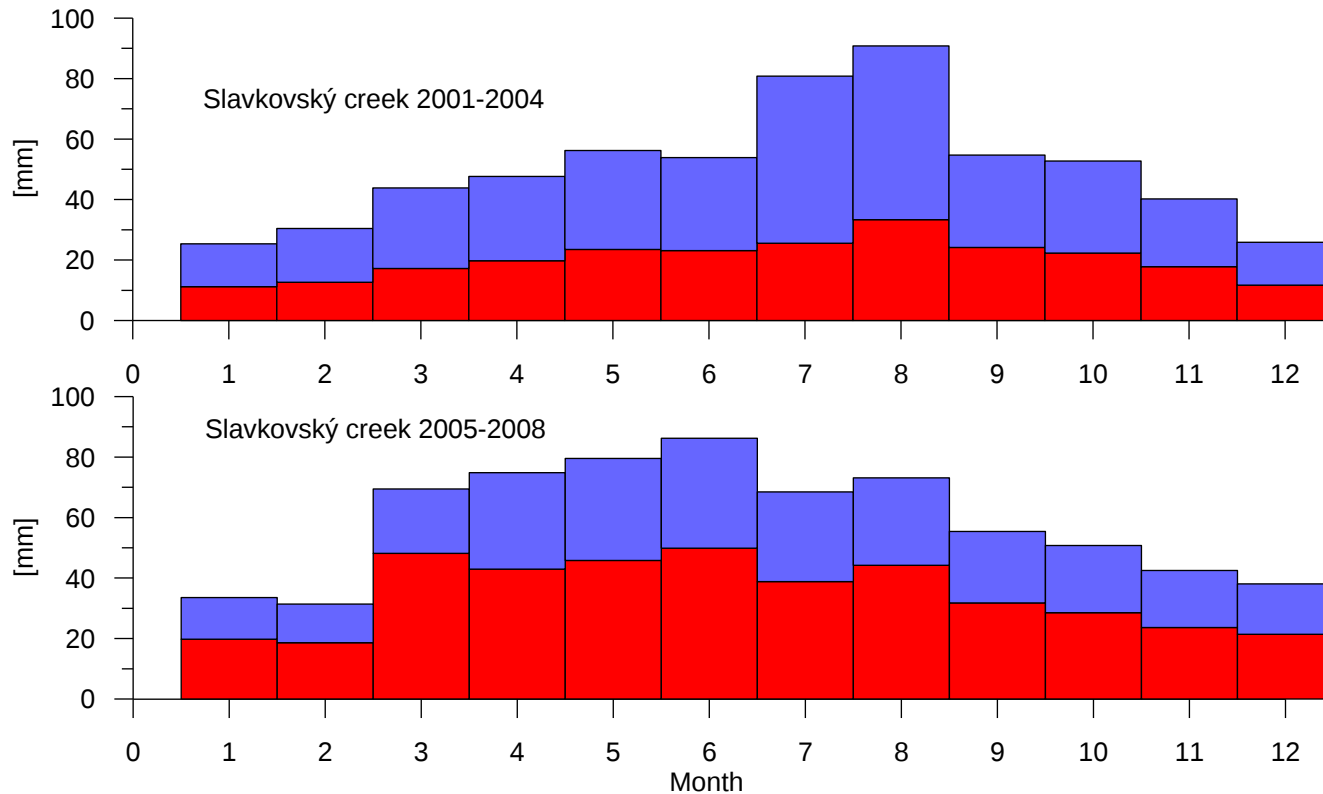
Mean monthly total runoff (blue) and baseflow (red) before and after the windfall

Velický creek - deforestation 20%

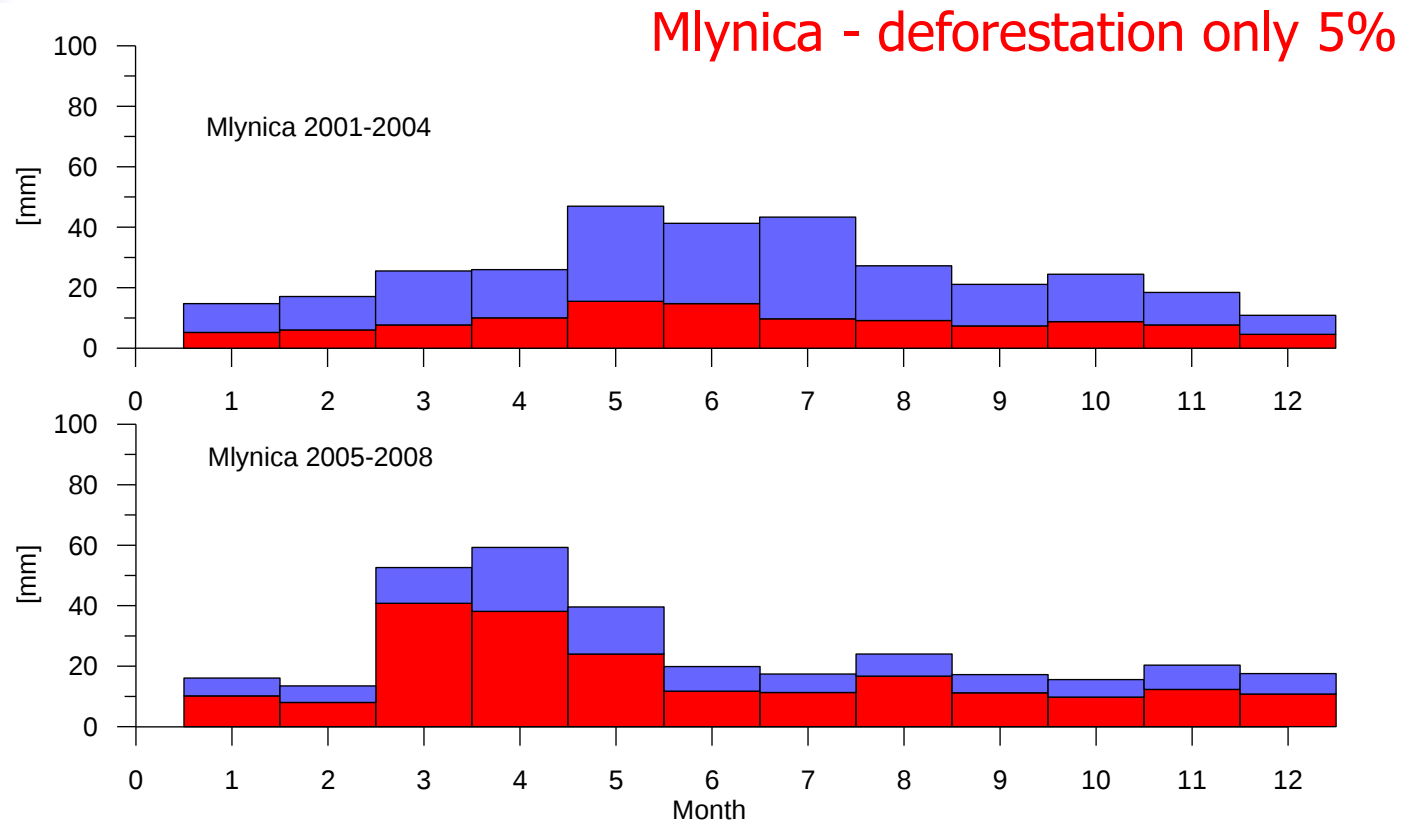


Mean monthly total runoff (blue) and baseflow (red) before and after the windfall

Slavkovský creek - deforestation 32%

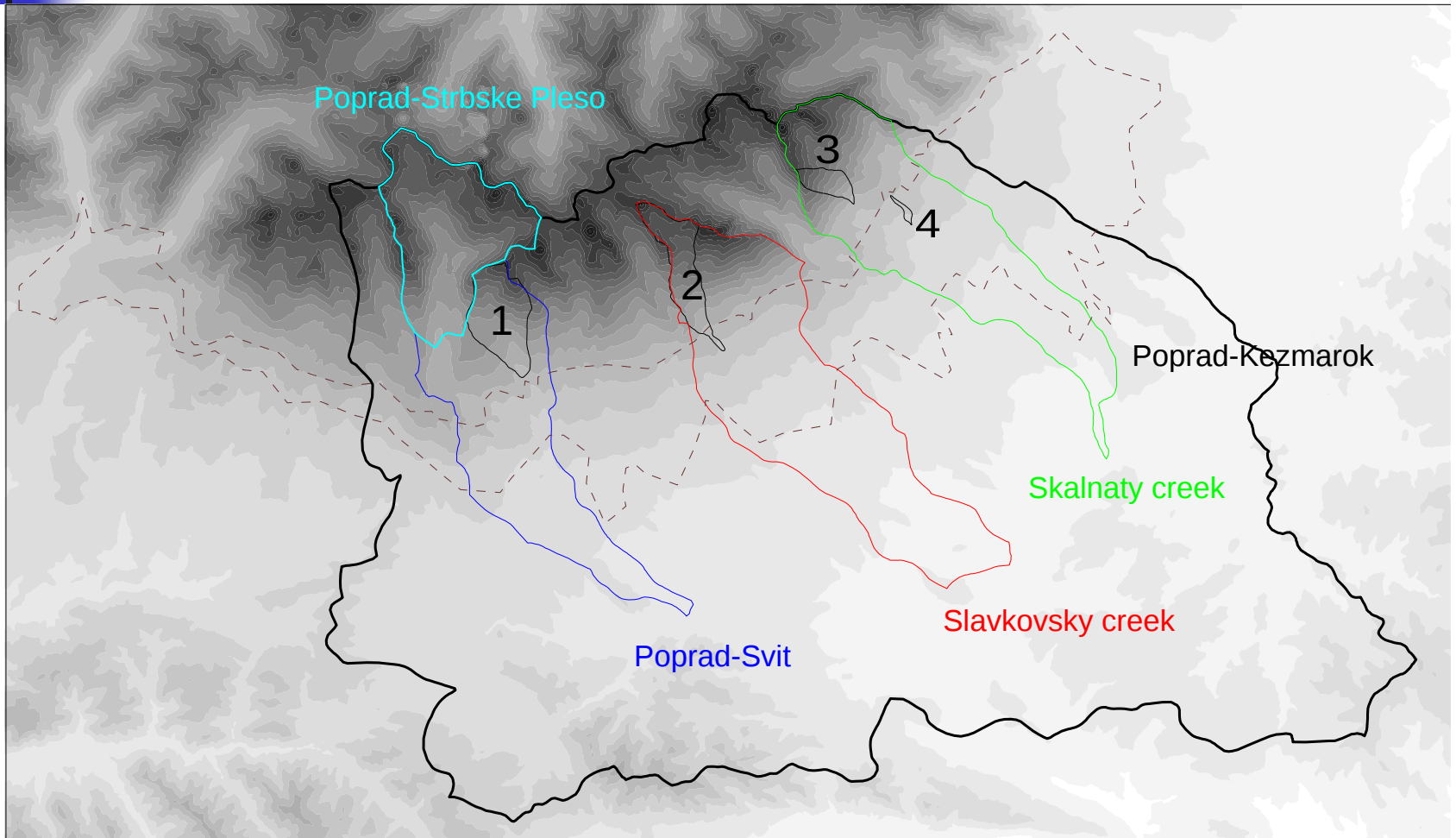


Mean monthly total runoff (blue) and baseflow (red) before and after the windfall



The change of baseflow seasonality was probably caused by other reasons than the windfall

New small catchments - nested within the previously monitored ones



Velký Šum - 4.6 km², 1592 m a.s.l.

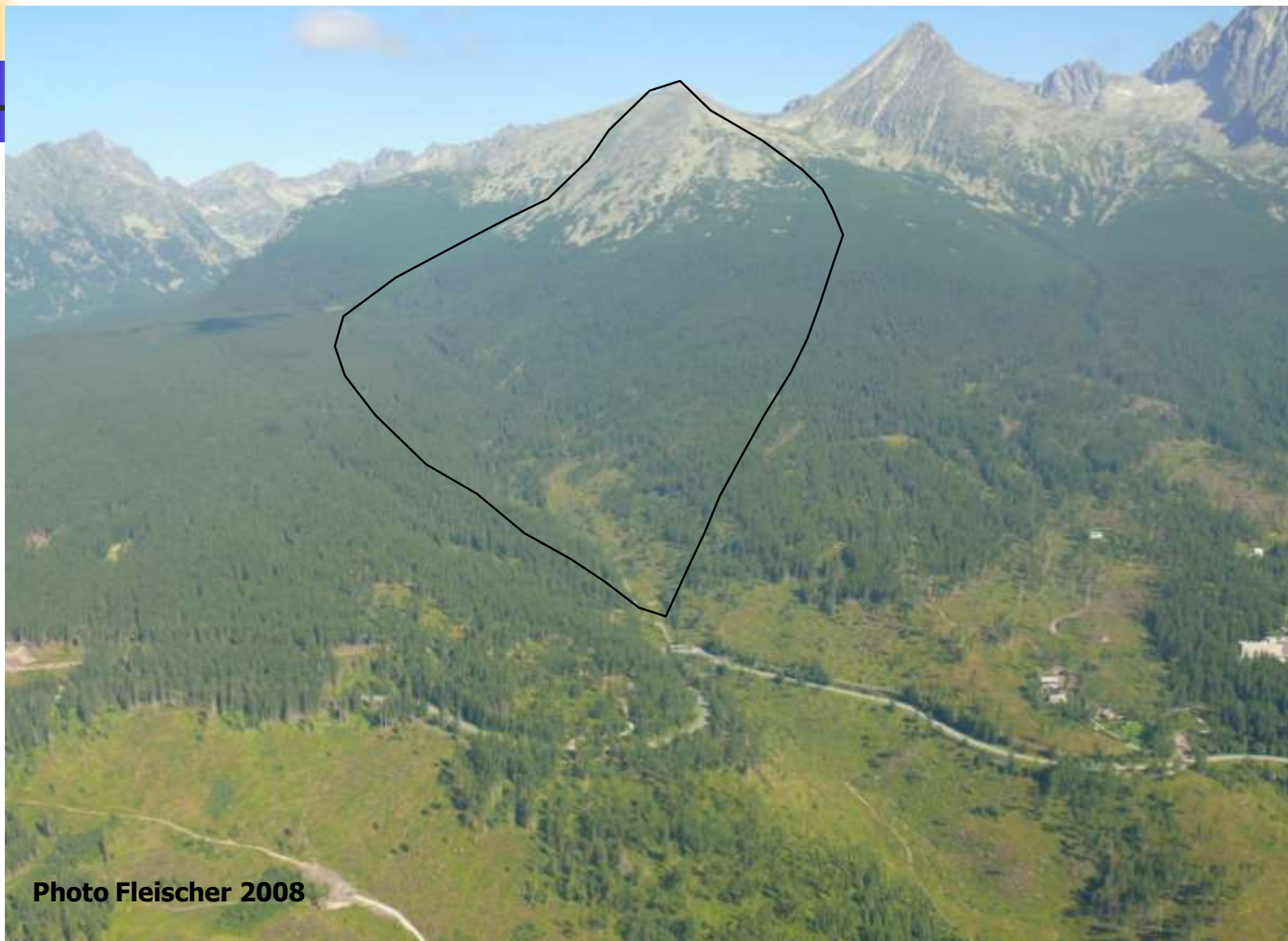


Photo Fleischer 2008

Slavkovský c.-fire - 3.7 km², 1759 m a.s.l.



Photo Fleischer 2008

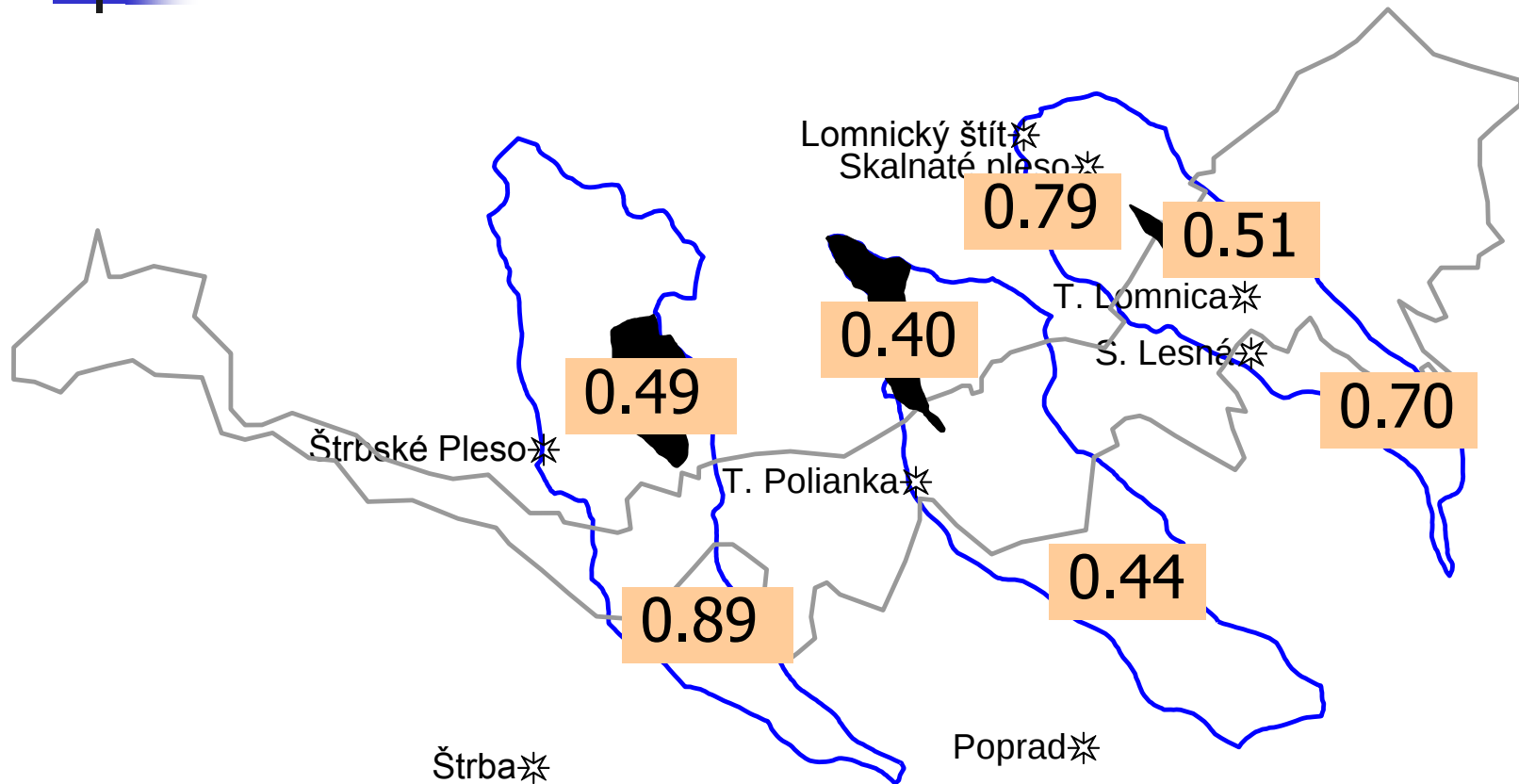
Škaredý creek - 1.1 km², 1564 m a.s.l.



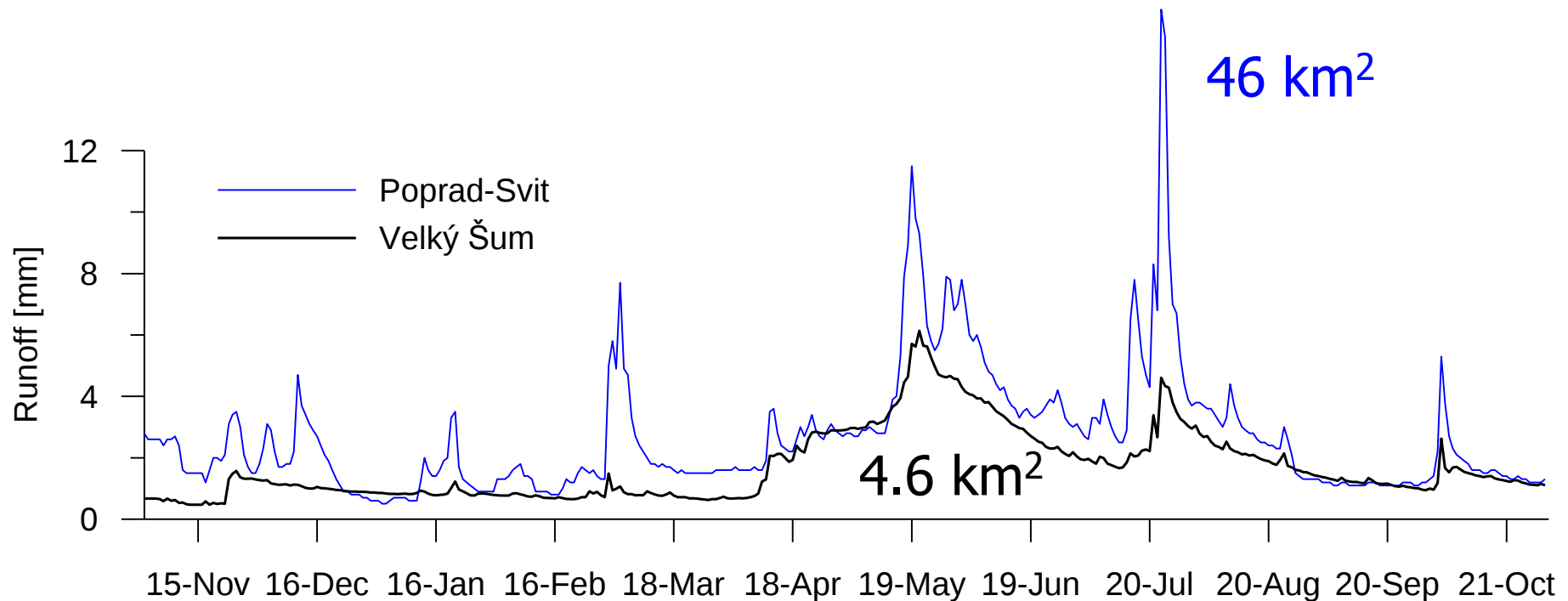
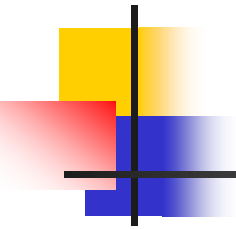
Jazierkový creek - 0.7 km², 1041 m a.s.l.

Photo Fleischer 2008

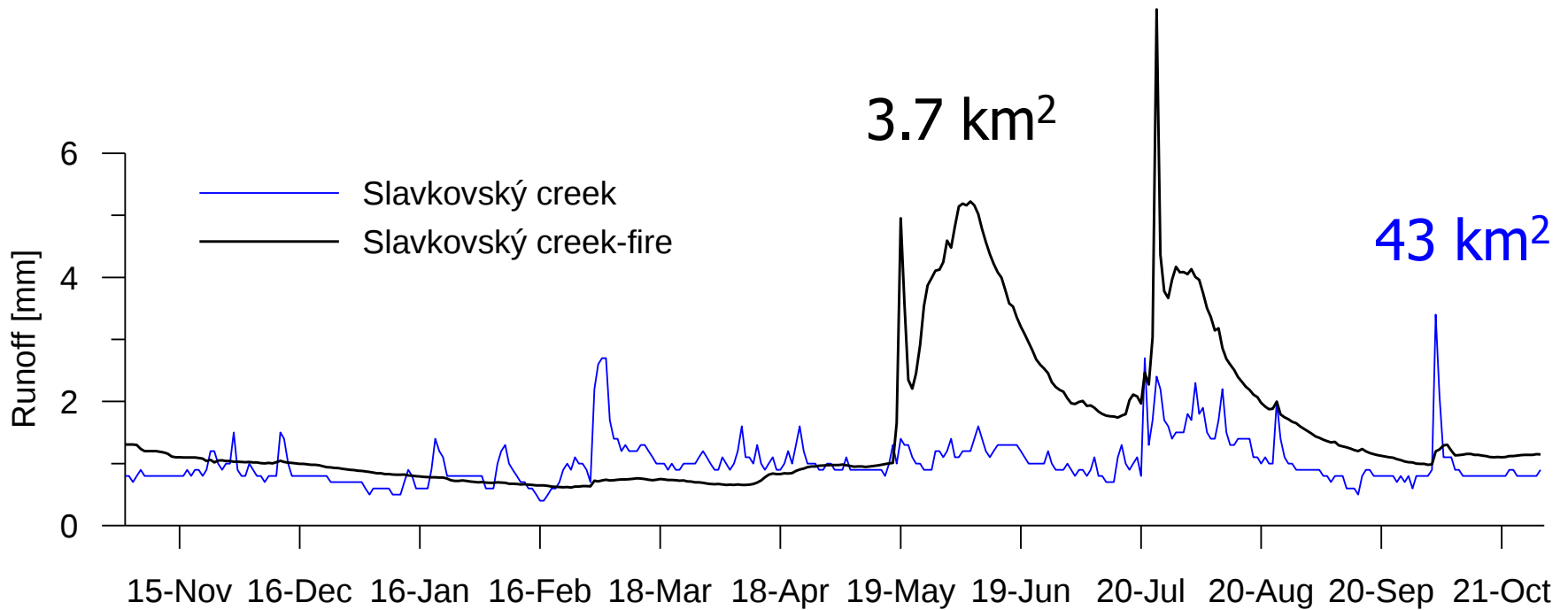
Runoff coefficients in the nested catchments (2008)



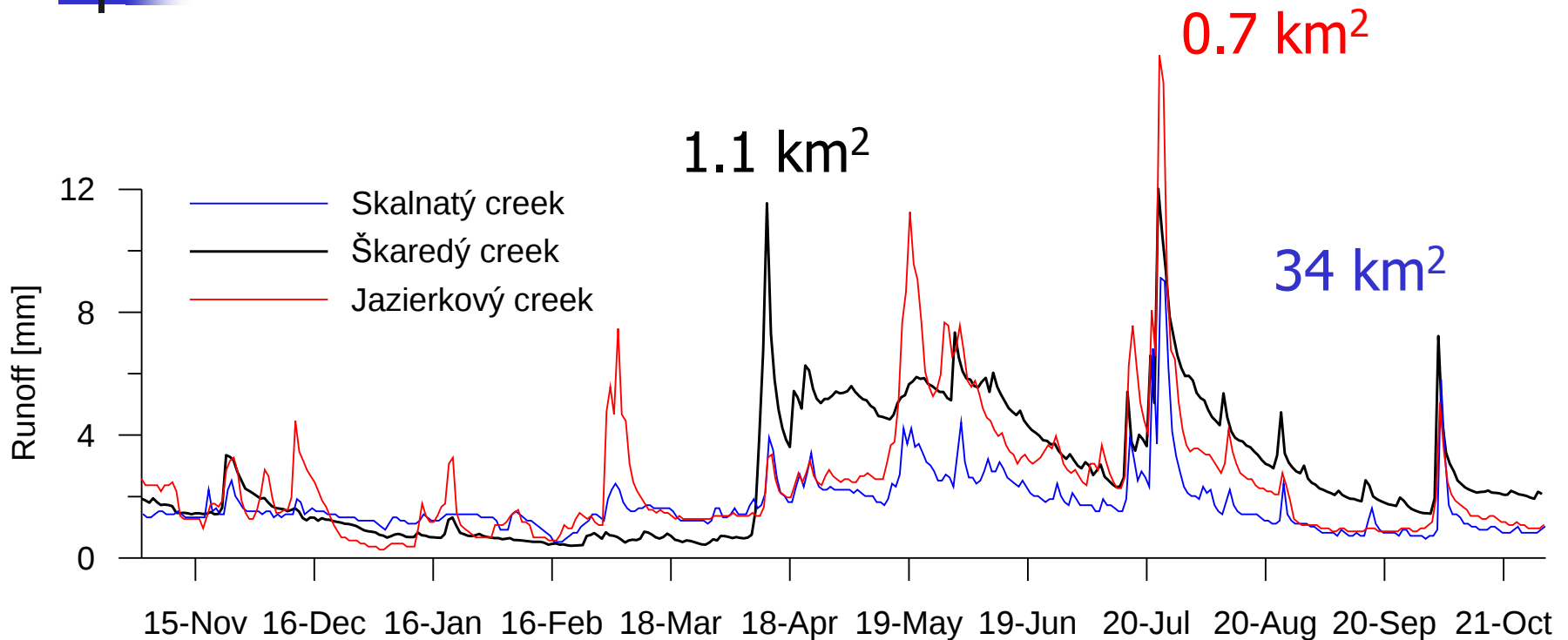
Comparison of discharges in the nested catchments (2008)

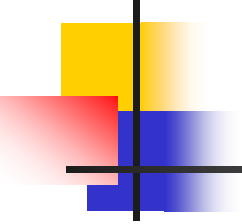


Comparison of discharges in the nested catchments



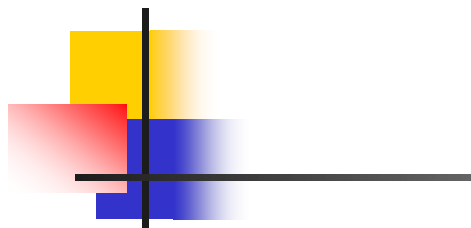
Comparison of discharges in the nested catchments





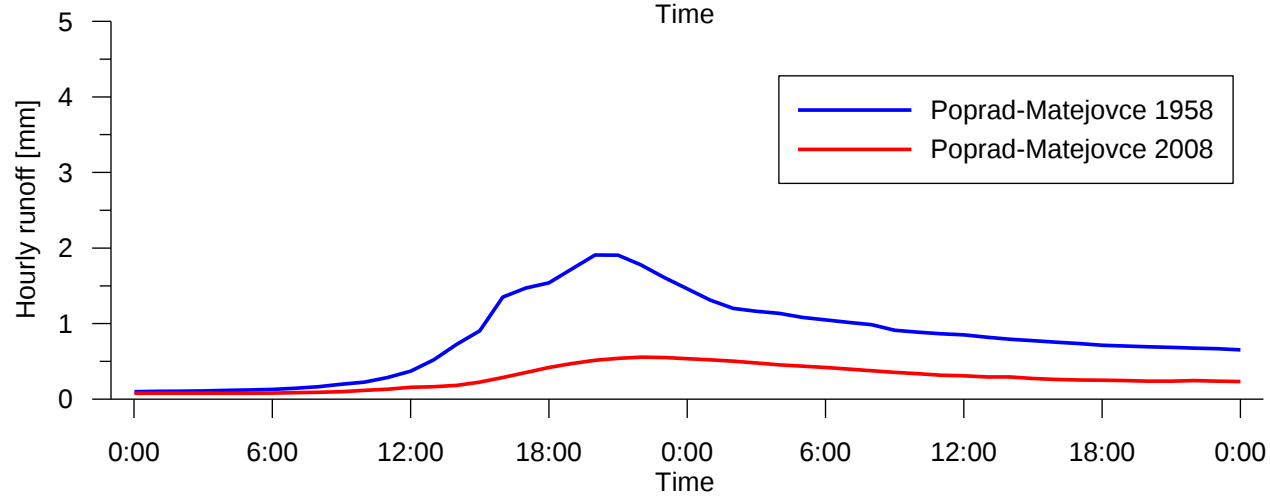
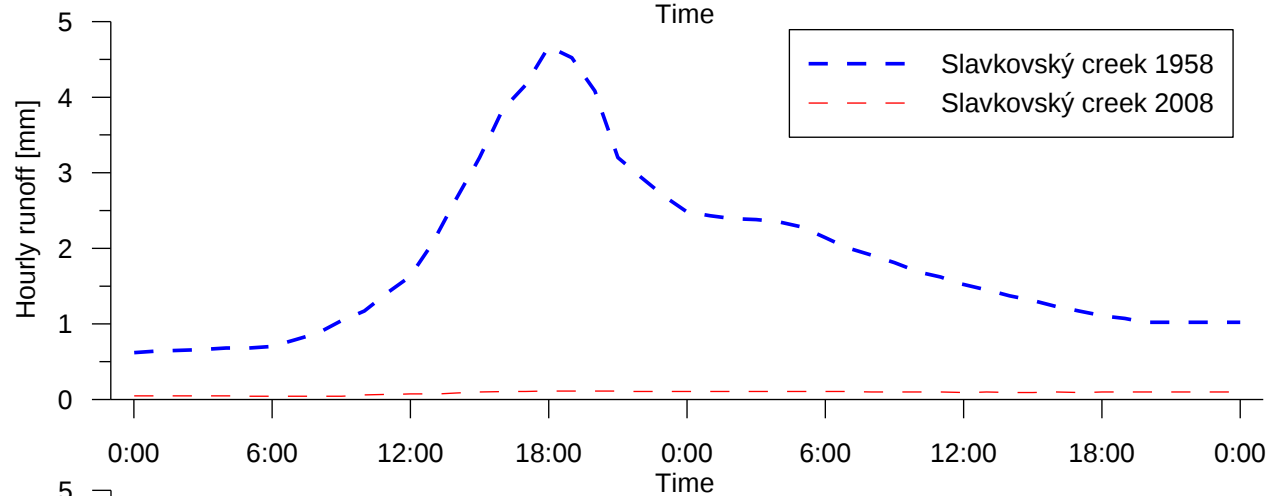
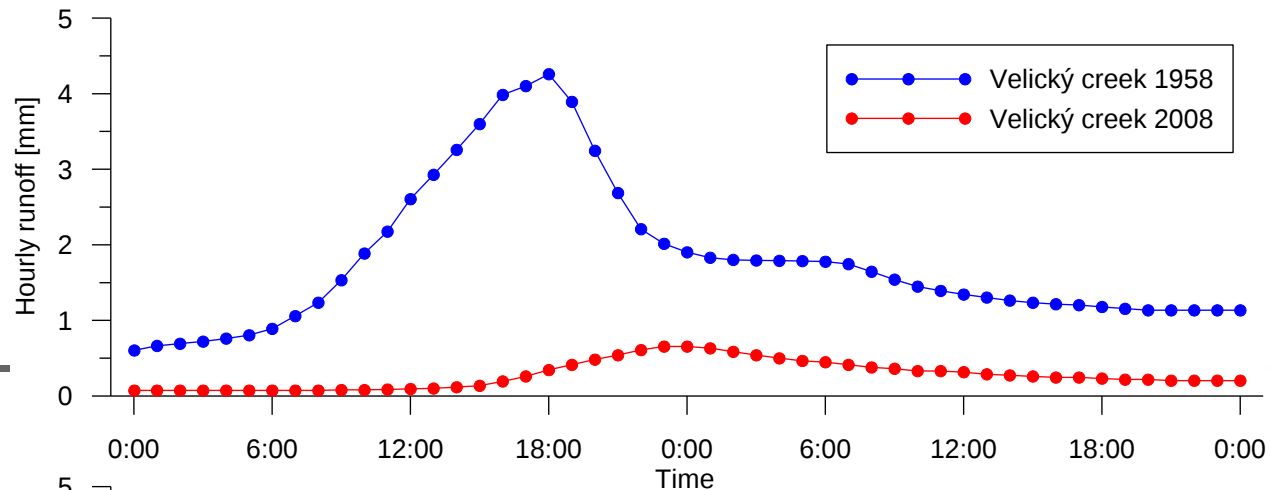
Hydrological reaction to extreme precipitation

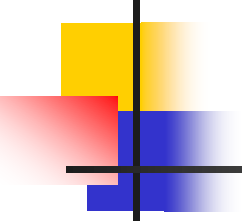
- The most extreme flood of the 20th century occurred in June 1958
- In July 2008 extreme precipitation in the northern part of the High Tatra Mountains occurred
- We have compared hydrological reactions of several catchments in June 1958 and July 2008



85-240 mm

40-90 mm

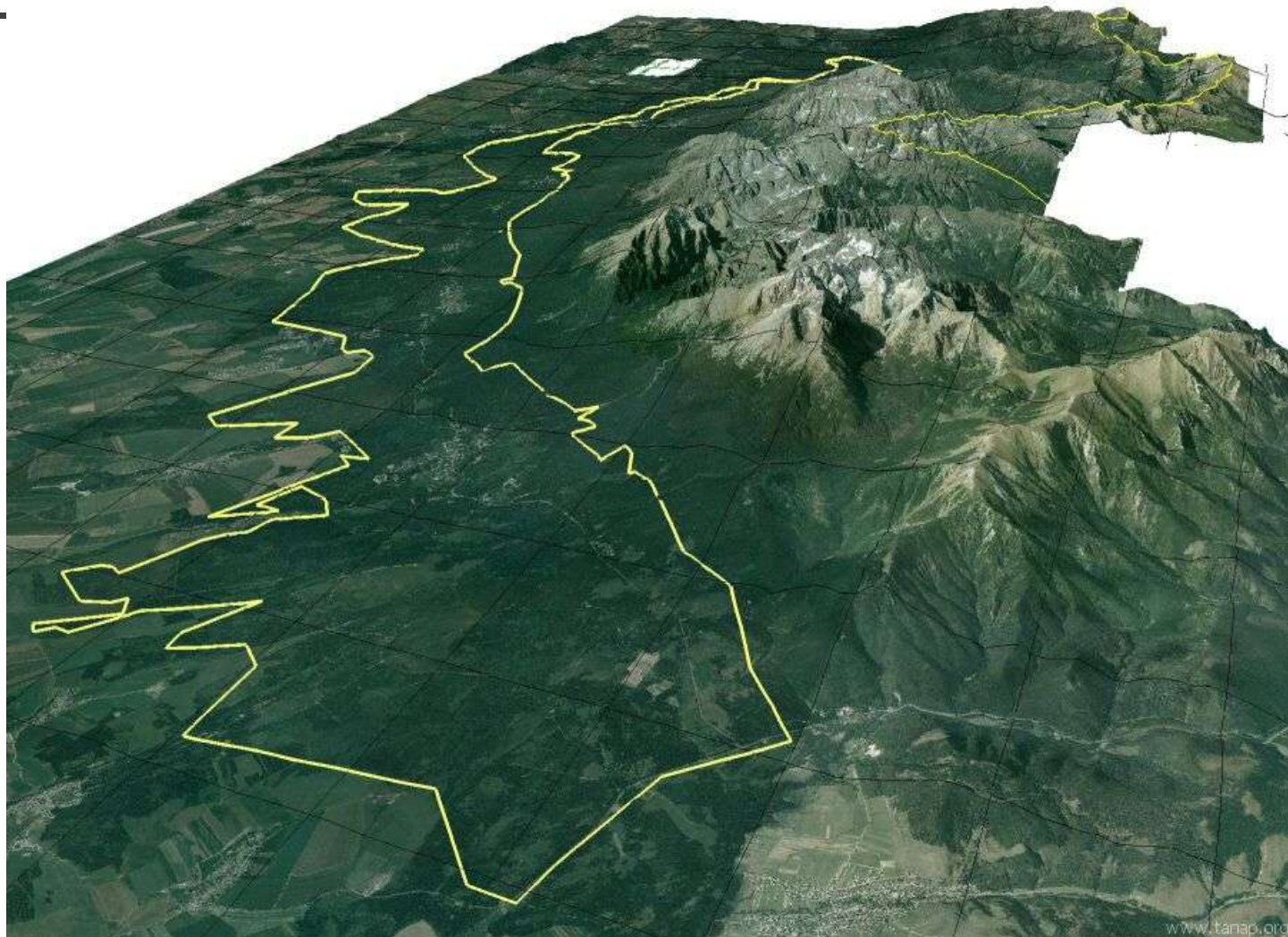




Conclusions

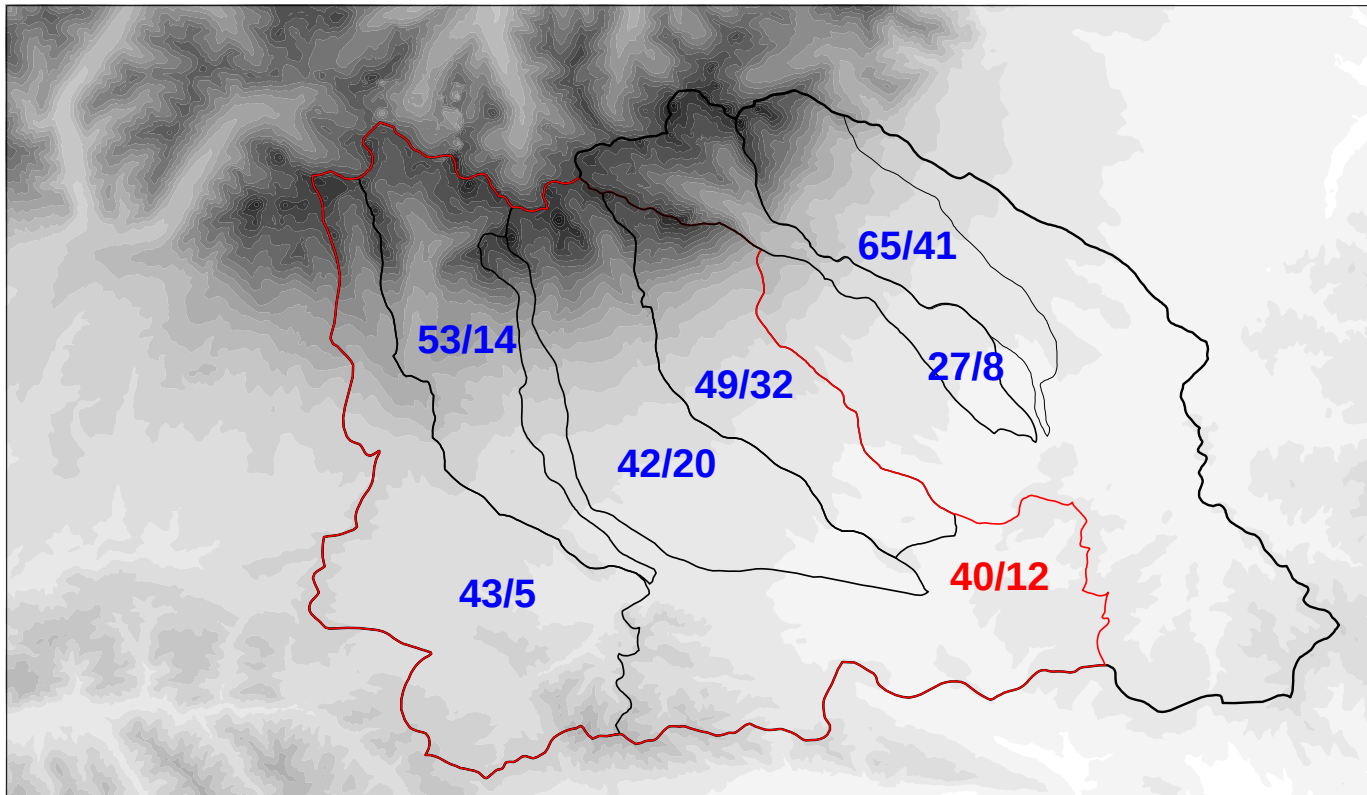
- Analysis of historical and newly measured data did not indicate significant changes in runoff regime
- Why?

Location of deforestation



Magnitude of deforestation

(forested area before windfall/ its decrease due to the windfall)



Last but not least – geology, soils (topography of the moraines)





Fast changes of the land surface



December 2004

September 2006



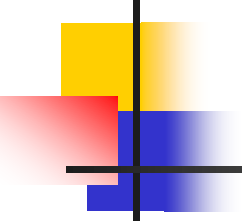
Fast changes of the land surface



March 2007

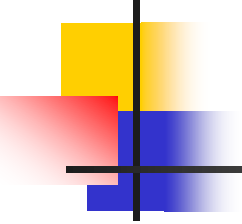
July 2007





Message

- The links between forests and floods are not straightforward
- The consequences of landuse changes should be communicated to the public with care



Thank you for your attention