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Hydrology of small forested microwatersheds II

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Content

1. Climate change effects
2. Precipitation – runoff system – forest influence
3. Stream flow measurement – base for the water balance evaluation
4. Forest and draught
5. Forest vs. open area
6. Different forest types (covers)

Climate change effects

- Annual temperatures increase 3°C per last 50 years in average
- Increasing trends continue
- Changes in precipitation distribution during the year
- Earlier coming of spring
- Longer and drier summer
- Longer growth season – longer transpiration period

Climate changes effect and forests

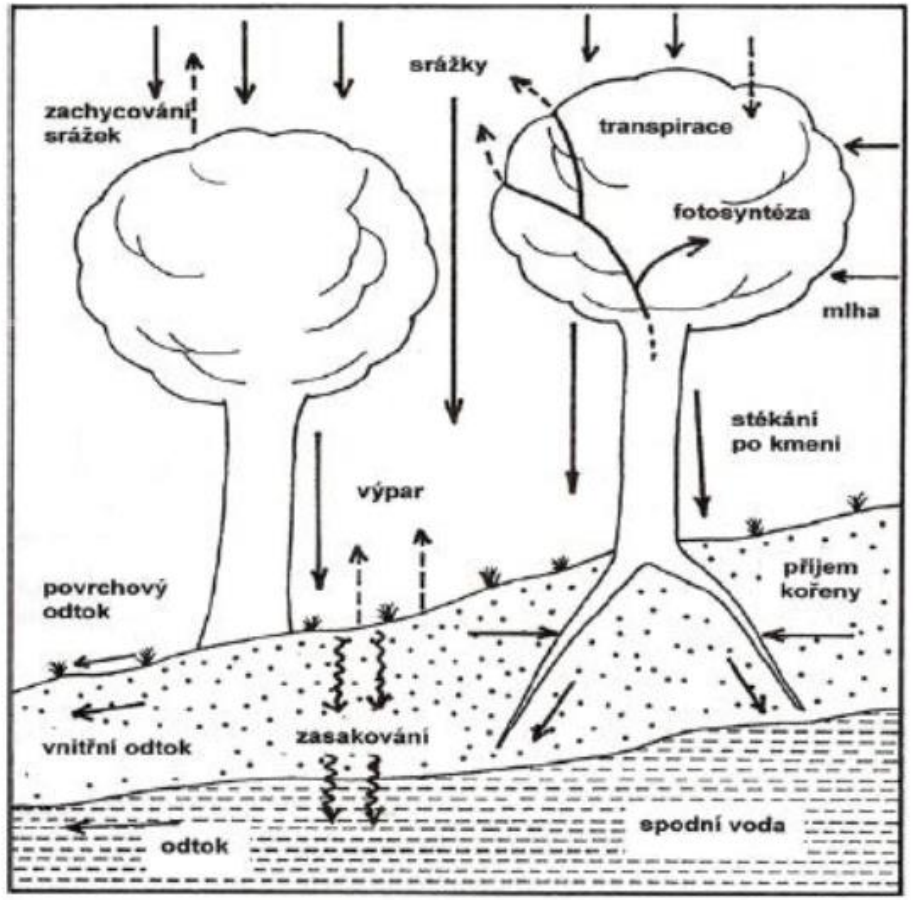
- Longer growth period – longer transpiration period – higher water need
- Changed precipitation distribution – lack of water in crucial forests living periods
- Disconnection between gravity and capillary soil water – lack of water in the rooting zone

PERMANENT STRESS

Forest and water cycle

- **Interception** – water captured on the leaves and branches surface – part of evaporation
- **Transpiration** – sap-flow, taking the water up by roots, running up through vessels and transpiring by the leaves
- **Evaporation** – water level, surface of vegetation
- **Infiltration** – soil water intake
- **Runoff** – surface vs. underground (soil x bedrocks)

Koloběh vody lesním ekosystému



Forest influences on landscape water cycle

- Forest complexes influence climate (water cycle) – evapotranspiration increases air humidity, returns water to the air
- Forest soil disposes of high retention capacity
  - Retains and accumulates water during precipitation periods
  - Releases water within dried periods

Forest influences on landscape water cycle

Example 1: Comparative analyses of the forested and open area

Deutscher J. a Kupec P., 2014. Monitoring and validating the temporal dynamics of interday streamflow from two upland head microwatersheds with different vegetative conditions during dry periods of the growing season in the Bohemian Massif, Czech Republic. Environmental Monitoring and Assessment DOI 10.1007/s10661-014-3661-5

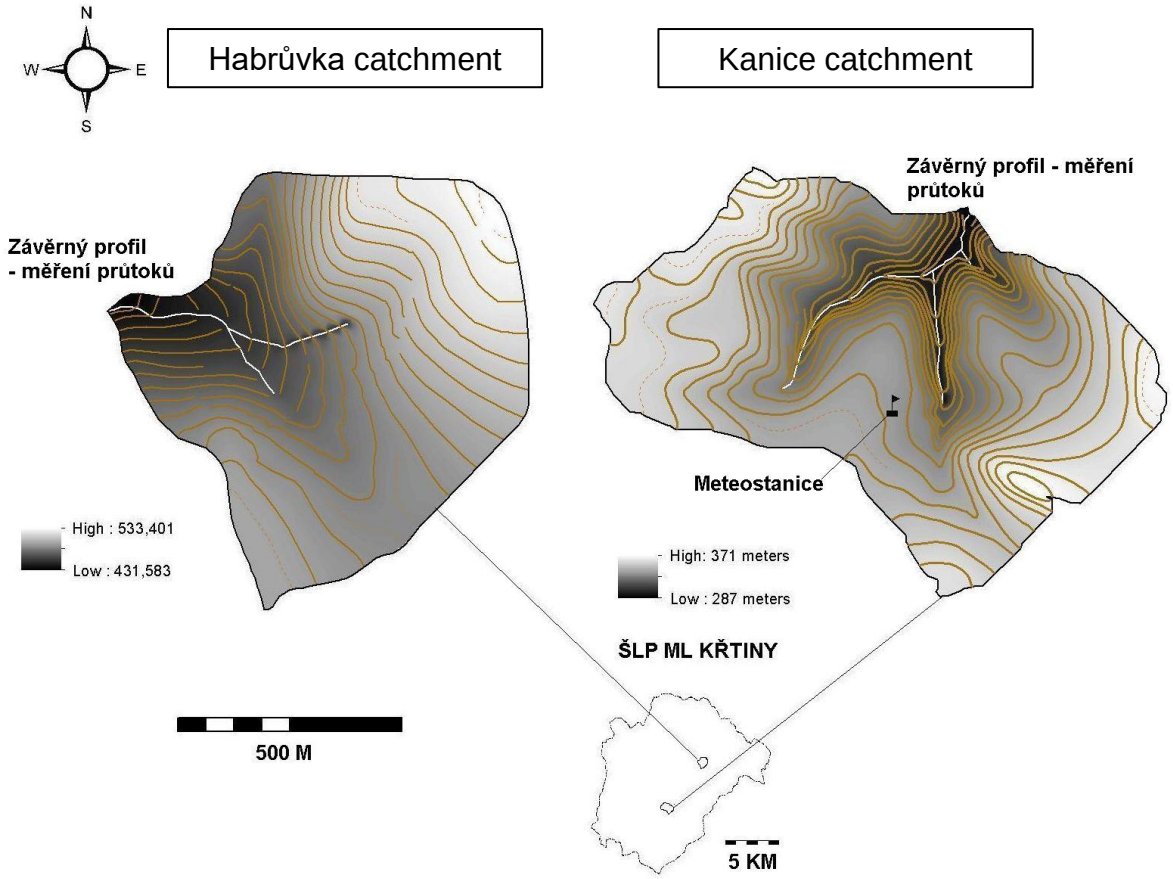
Example 2: Comparative analyses of the forested catchments with different tree species composition

Kupec P., Školoud L. and Deutscher J. 2018. Tree species composition influences differences in water use efficiency of upland forested microwatersheds. European Journal of Forest Research (2018): 1-11.

Methodology

- Net of stabilized experimental catchments
- Net of automatic climatological stations – data logged in interval of 15 minutes
- Stream-flow measurement – Thomson spillways, press or ultrasound sensors, data logged in interval of 15 minutes
- Additional measurements – sap flow, soil moisture, surface runoff, throughfall etc.
- Precipitation-free period – periods without rain longer than 5 days
- Data processing – trends of stream-flow of the experimental catchments recipients within the same precipitation free periods

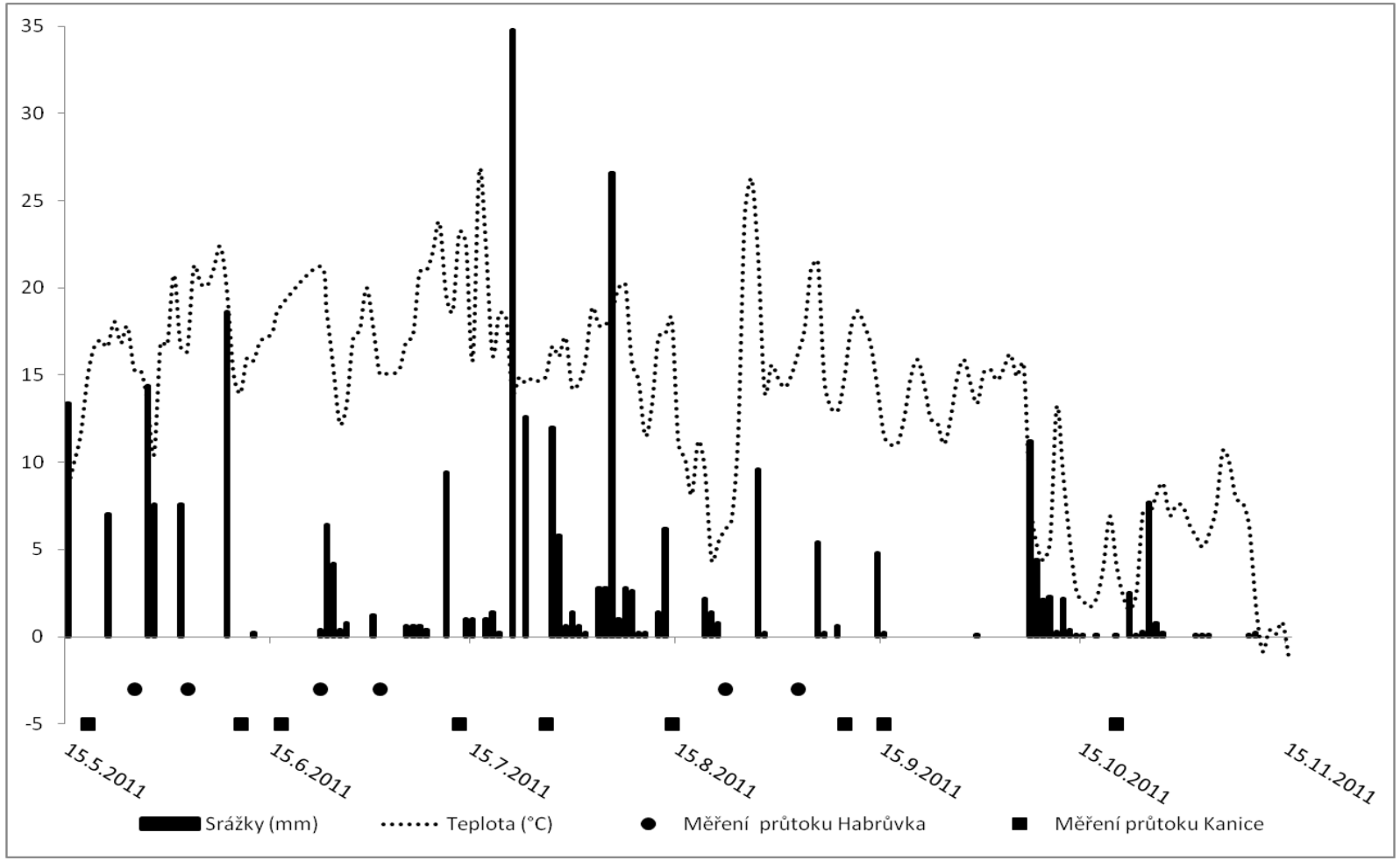
Example 1: Comparative analyses of the forested and open area - 2011



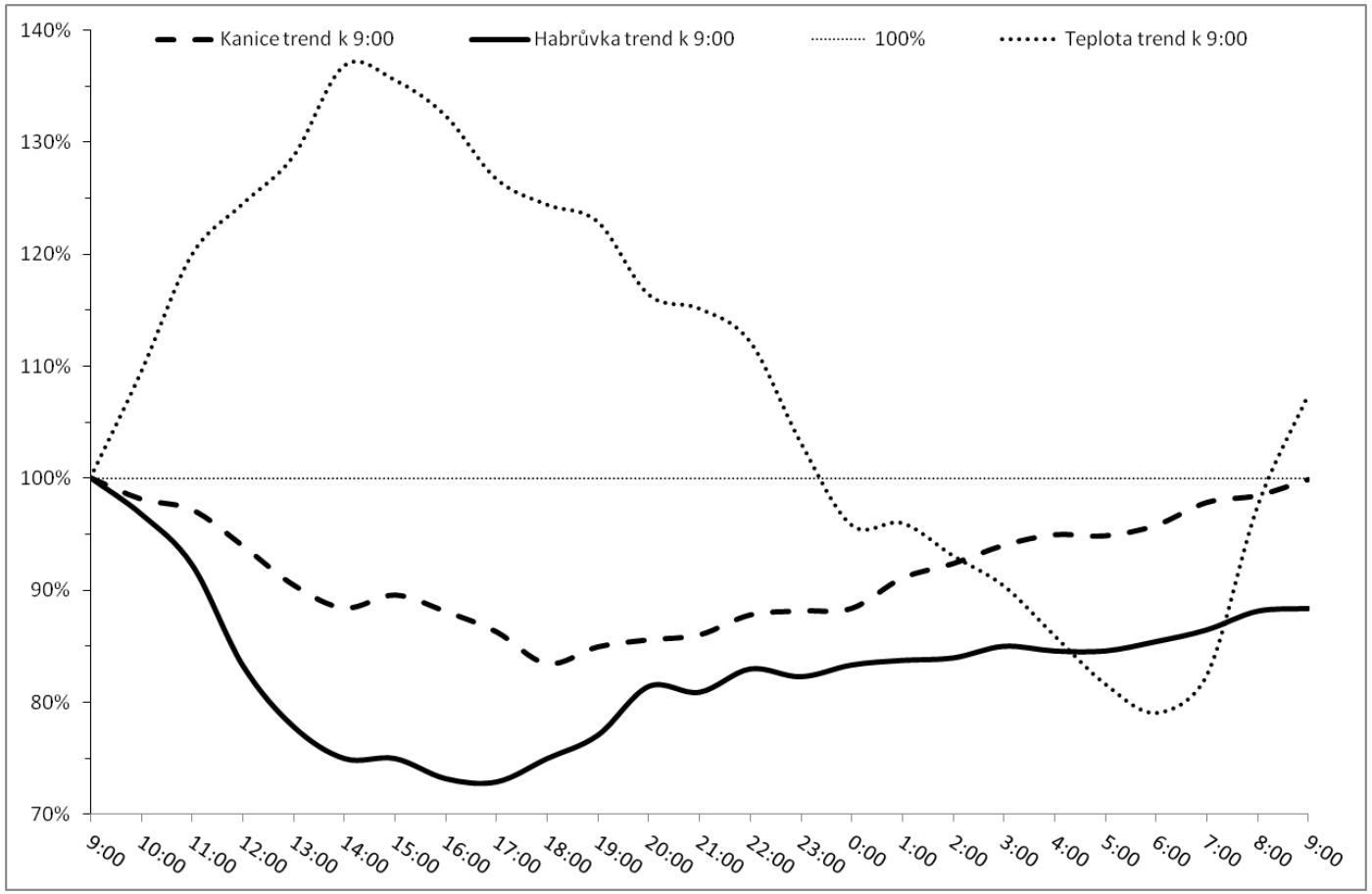
Basic characteristics of the catchments

Characteristic	Kanice	Habrůvka
Catchment area (ha)	65	50
Main recipient lenght (m)	640	680
Average altitude (m a. s. l.)	332	480
Exposition	North	Norhwest
Forest coverage (%)	98	10
Tree species composition (%)	*Fagus sylvatica* 25, *Pinus sylvestris* 20, *Quercus petrea* 15, *Tilia plathyphyllos* 15, *Picea abies* 10, *Carpinus betulus* 10, *Larix decidua* 5	*Fagus sylvatica* 55, *Acer pseudoplatanus* 20, *Fraxinus excelsior* 15, *Larix decidua* 10

Climate-graph Kanice 2011 – precipitation free periods identification



Stream flow trends in precipitation-free periods Kanice vs. Habrůvka 2011



Stream flow trends in precipitation-free periods Kanice vs. Habrůvka 2011

Results

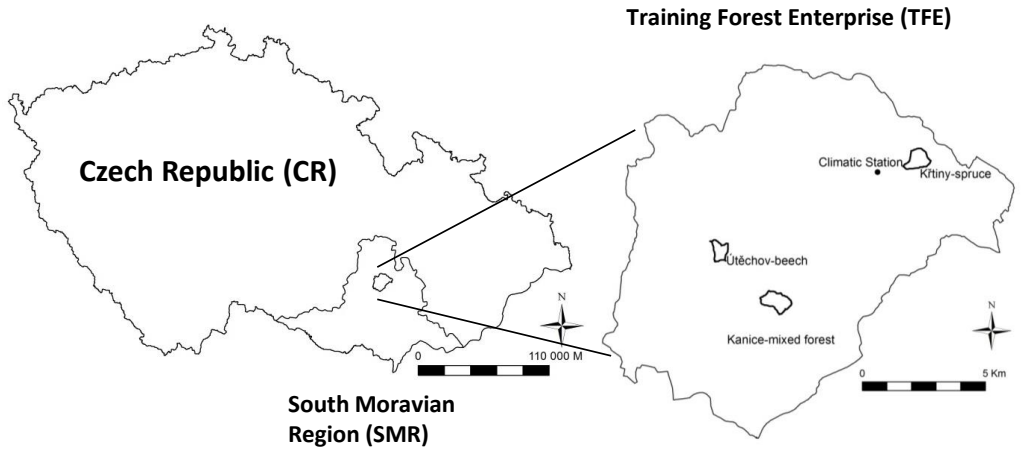
- Equal trend of stream-flow decreasing within the sunlight part of the day
- Open catchment reaches the minimal values od stream-flow nearly two hours before the forested catchment
- Maximal daily stream-flow decrease achieves 27 % of base flow in case of open catchment and only 17 % in case of afforested one
- In night the open catchment stream-flow stagnates and in early morning reaches 90% of the original base flow while the afforested catchment streamflow grows continuously to achieve 100% of base flow

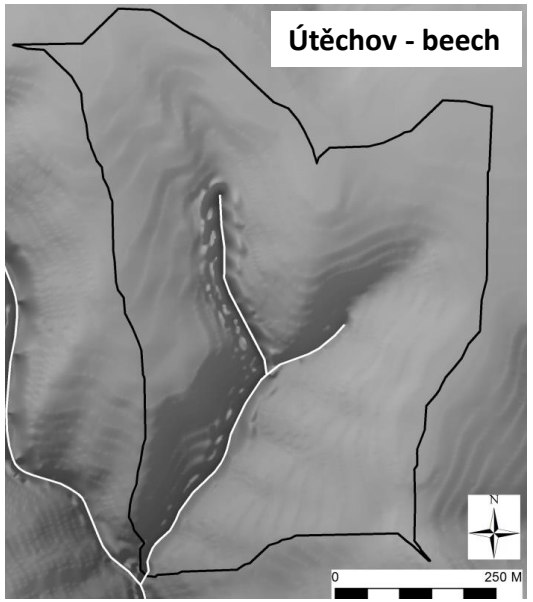
Stream flow trends in precipitation-free periods Kanice vs. Habrůvka 2011

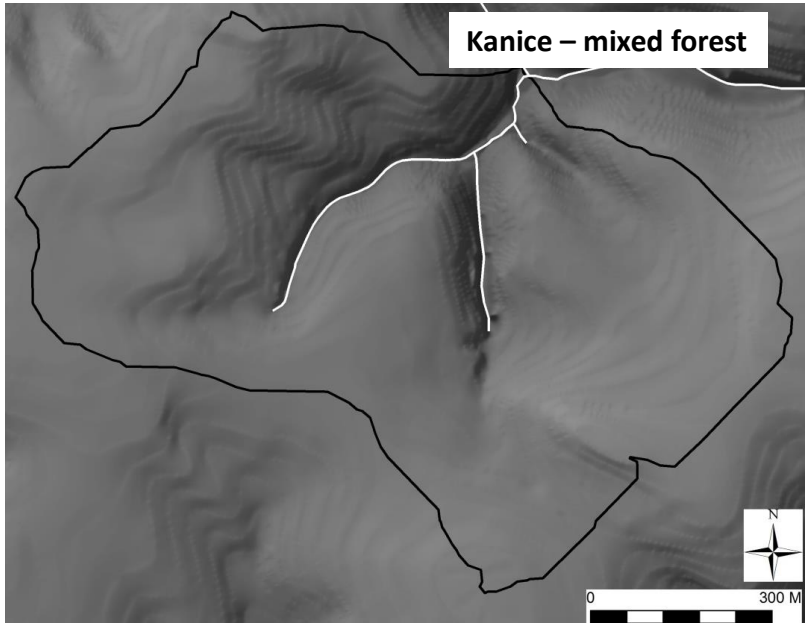
Final message

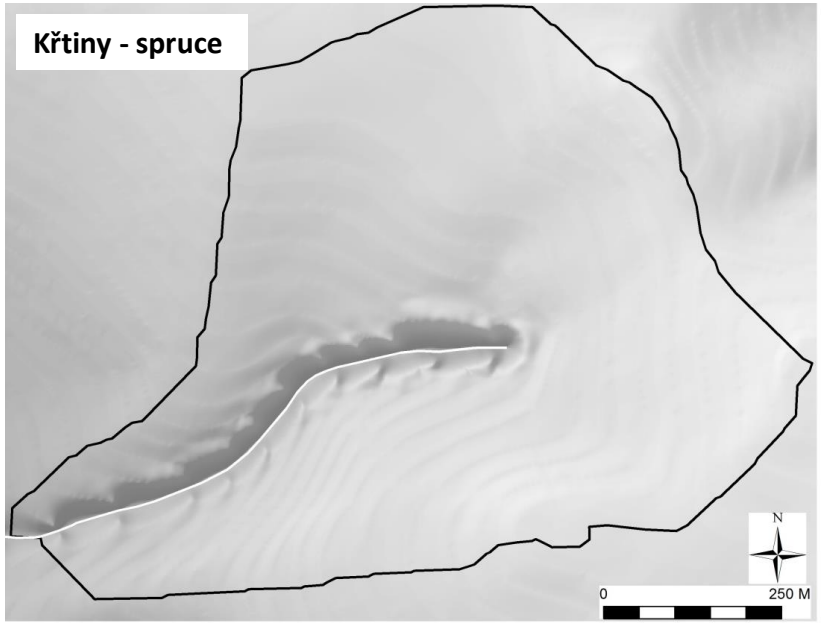
Open forestless catchment is losing 10% of stream-flow amount in comparison with the long-time base flow during the precipitation-free periods within growth period while afforested catchment keeps the stream-flow still on the value of 100% of original base flow

Example 2: Comparative analyses of the forested catchments with different tree species composition - 2015

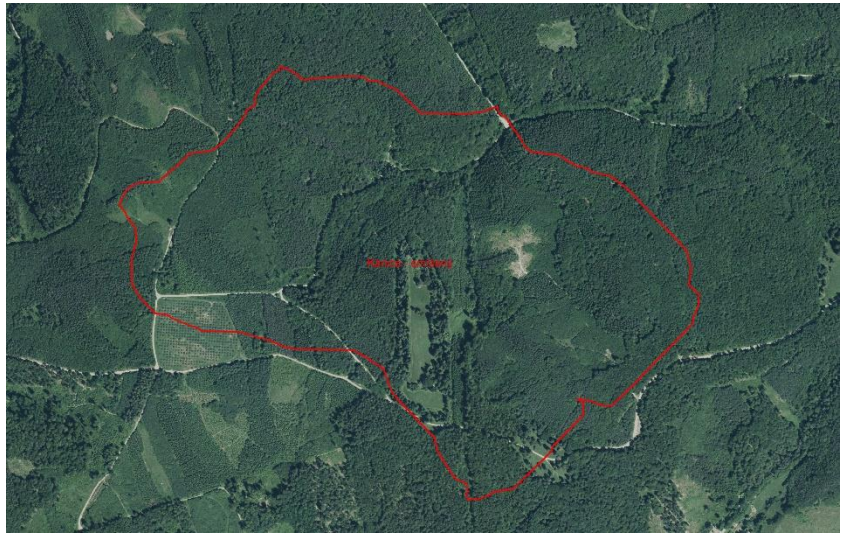


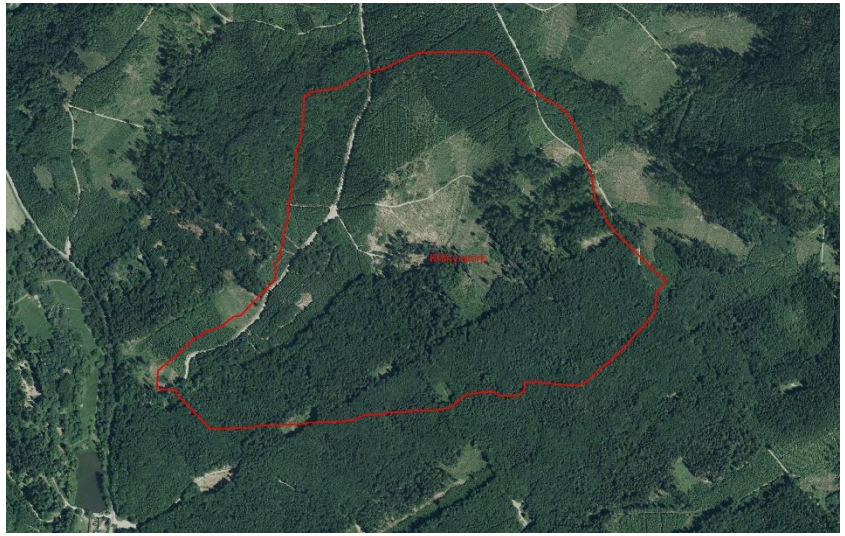






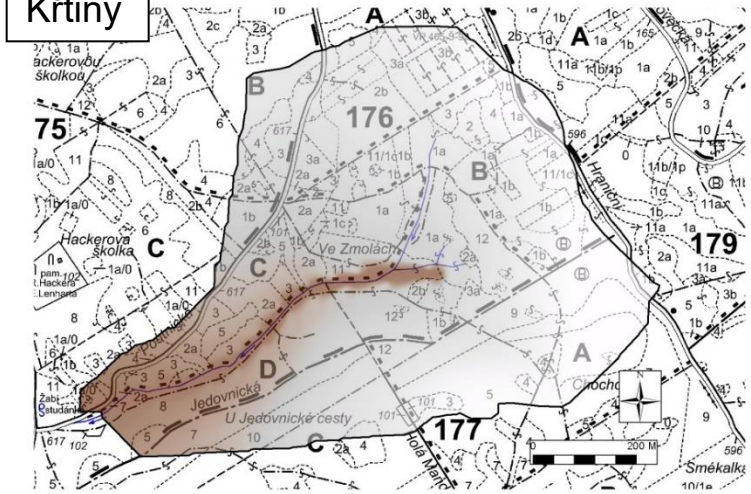
Basic characteristics of the catchments



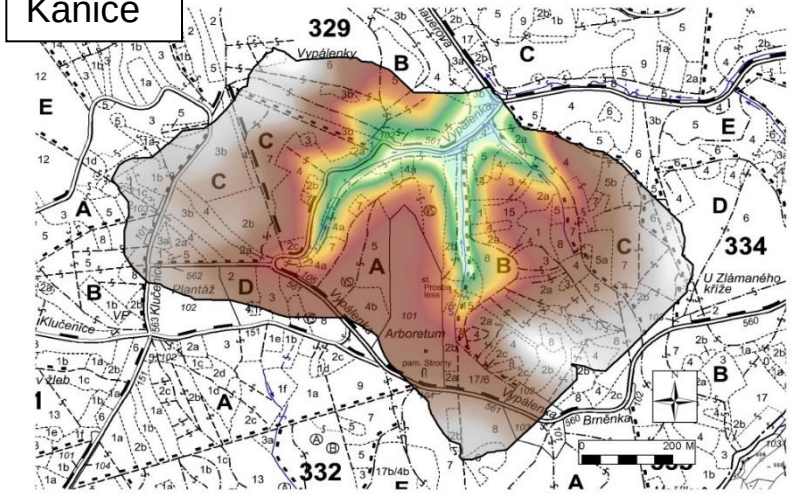


Basic characteristics of the catchments

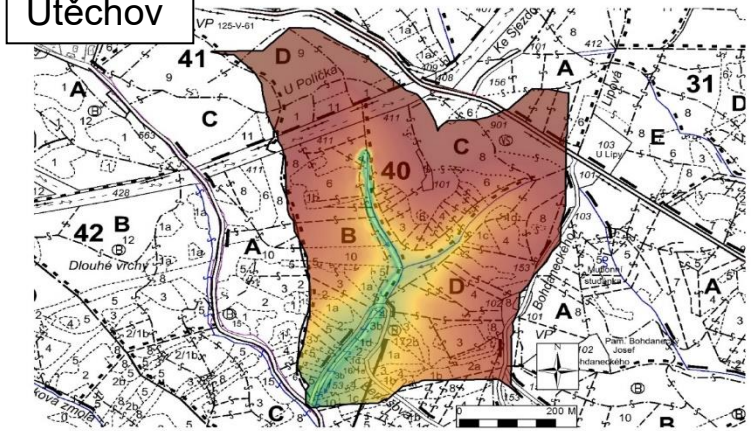
Křtiny



Kanice



Útěchov



Basic characteristics of the catchments

Basic characteristics	Křtiny	Kanice	Útěchov
Area (ha)	57	65	38
Main recipient lenght (m)	940	640	660
Maximal altitude (m a.s.l.)	563	371	325
Minimal altitude (m a.s.l.)	456	287	452
Mean altitude (m a.s.l.)	521	341	411
Exposition	east	north	southeast
Average steep slope (%)	21	17	38
Forest coverage (%)	100	98	100
Dominant tree species	Spruce	Mixed (BK29, DBZ20, BO19, HB17, MD15)	Beech

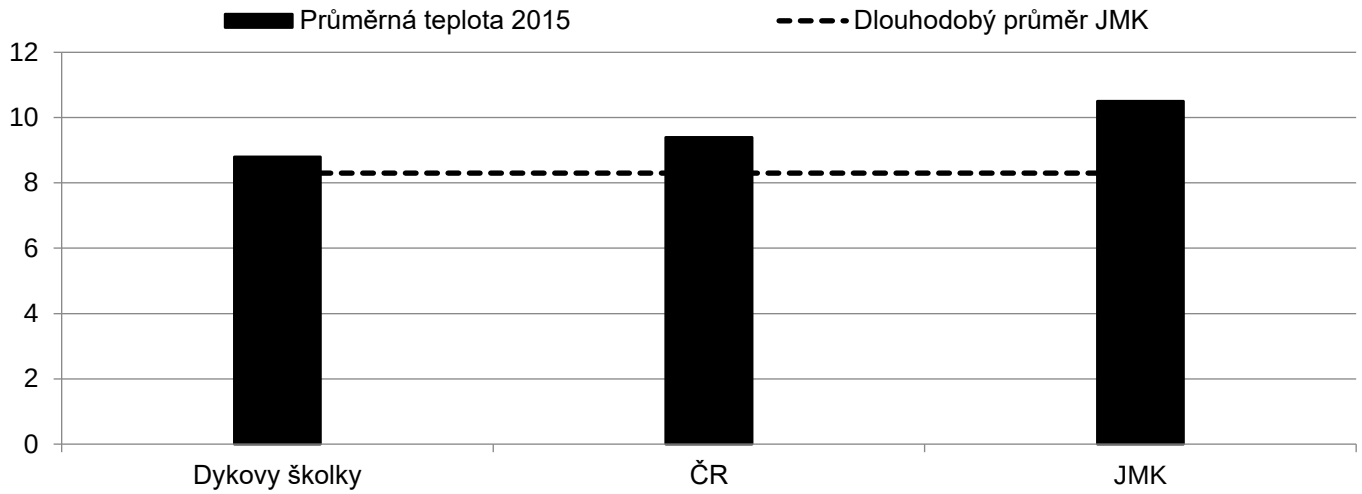
Measurement profile

Kanice

Křtiny

Útěchov

Relevant temperature characteristics - 2015



Long time annual mean temperature South Moravian Region 1961 – 1990 (CHMI)	Dyk´s nursery annual mean temperature 2015 (532 m n.m.)	Czech Republic annual mean temperature 2015 (CHMI)	South Moravian Region annual mean temperature 2015 (CHMI)
8,3°C	8,8°C	9,4°C	10,5°C

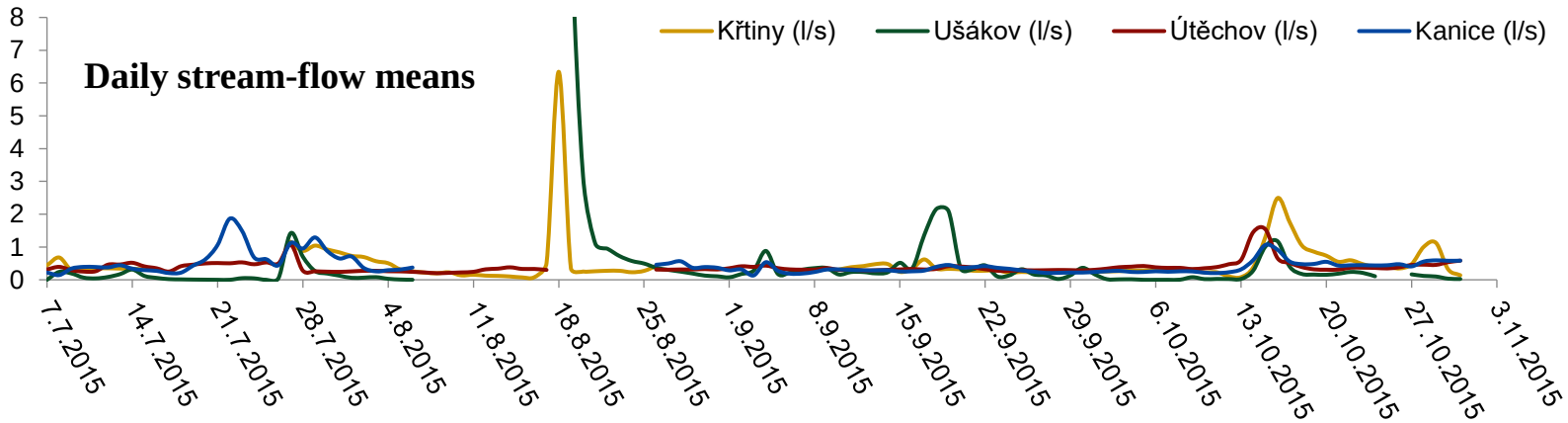
Precipitation-free periods identification- growth period 2015

Month	Month precipitation sum (mm)	Days of precipitation
July	47	13
August	69,6	5
September	20,2	10
October	52,2	12

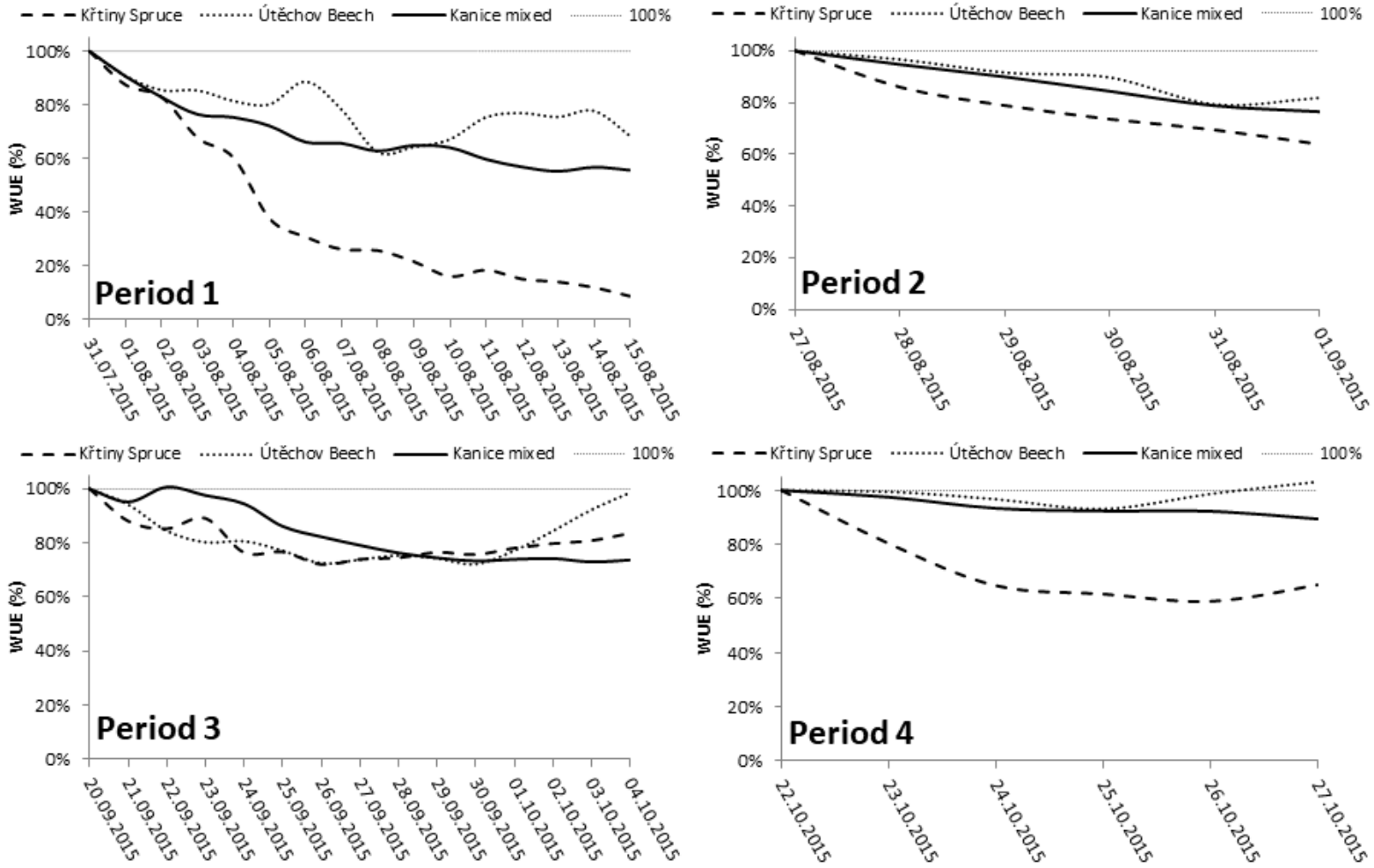
Precipitation-free period	Start	End	Duration (days)	Sum of previous continuos precipitation (mm/days)
1	31.7.16 8:00	16.8.16 8:00	17	30,6/6
2	27.8.16 8:00	1.9.16 8:00	6	69,6/5
3	20.9.16 9:00	5.10.16 9:00	16	3,8/6
4	22.10.16 8:00	28.10.16 8:00	7	50/8

Stream-flow characteristics - growth period 2015

Stream-flow characteristics		Křtiny		Útěchov		Kanice	
		l/s	Date, hour	l/s	Date, hour	l/s	Date, hour
Minimal stream-flow	hourly	0,04	16.8. 1:00	0,10	13.9. 16:00	0,06	8.7. 11:00
	daily	0,07	15.8.	0,20	8.8.	0,13	3.9.
Maximal stream-flow	hourly	19,59	18.8. 2:00	6,46	27.7. 16:00	5,04	27.7. 15:00
	daily	6,34	18.8.	1,54	15.10.	1,86	22.7.
Mean stream-flow	hourly	0,50		0,38		0,44	
	daily	0,50		0,39		0,44	



Stream-flow trends - growth period 2015



Comparative analyses of the forested catchments with different tree species composition - results

- Highest WUE (Water use efficiency) reaches beech forest stand (80%)
- Spruce achieves very low WUE especially during the long time precipitation-free period (less than 10%)
-

Comparative analyses of the forested catchments with different tree species composition - results

Final messages

- Significant difference of WUE of different tree species compositions in different parts of growth season
- Planting of spruce in the area od uplands is regarding to the GCC very problematic
- Uplands – spruce only as admixed (30% in maximum)

Thank you for your kind attention

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