Functional Effects of Forest Ecosystems on Water Cycle – Slovakia case study

Ing. Martin Bartík, PhD., Technical University, Zvolen Slovakia

Doc. RNDr. Ing. Jozef Minďaš, PhD., University of Central Europe, Skalica, Slovakia

Prof. Ing. Jaroslav Škvarenina, CSc., Technical University, Zvolen Slovakia

Forest hydrology – 4 examples

What is a real influence of forest ecosystems on water cycle in landscape ?

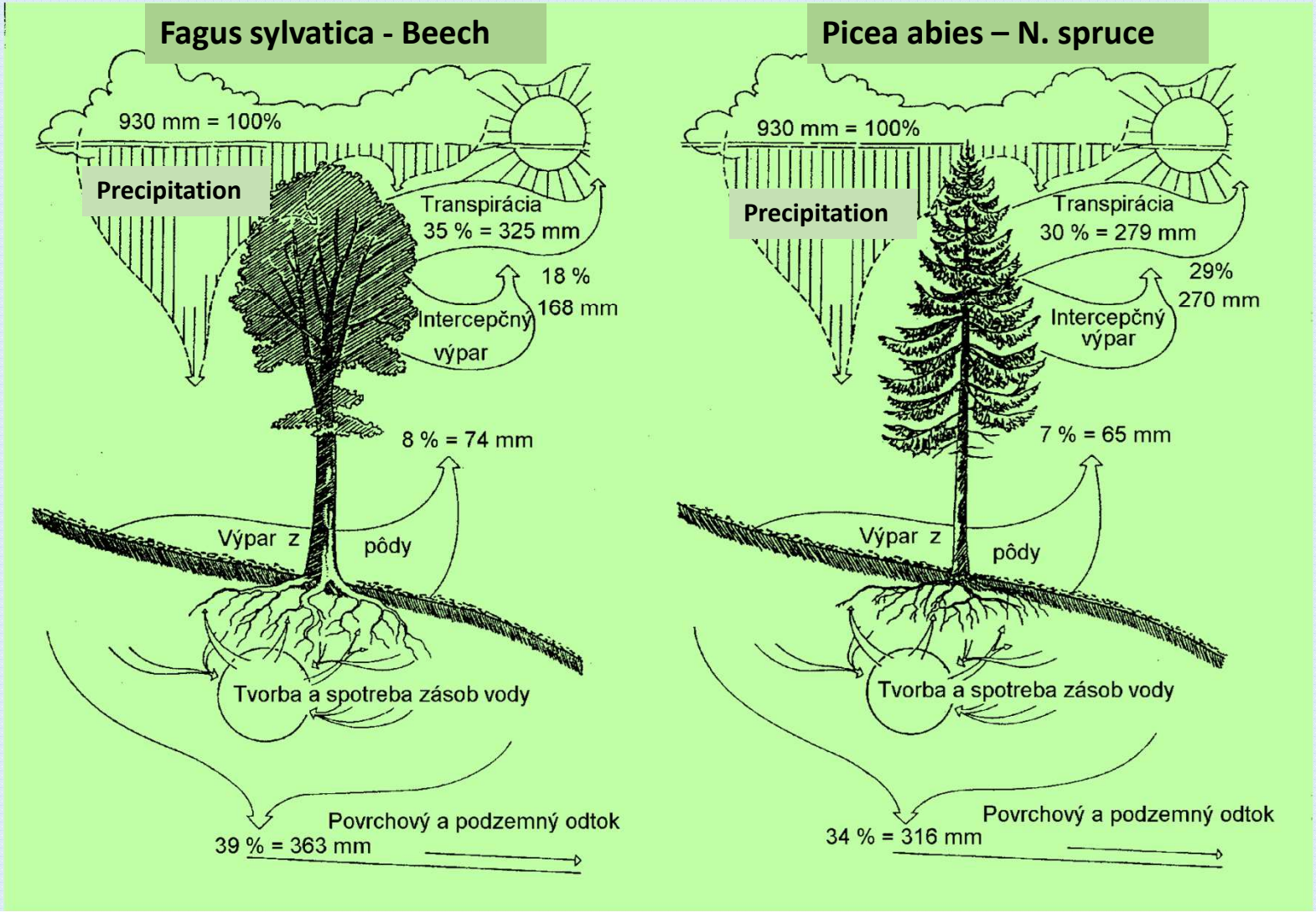
<u>4 practical examples</u>

- Tree species composition – influence on throughfall precipitation (Poľana Mts.)
- Forests in small catchment – precipitation and throughfall variability (Low Tatras Mts.)
- Norway spruce forests – precipitation and surface runoff (Kysuce region)
- Mountain spruce forests – throughfall variability due to canopy architecture (West Tatras Mts.)

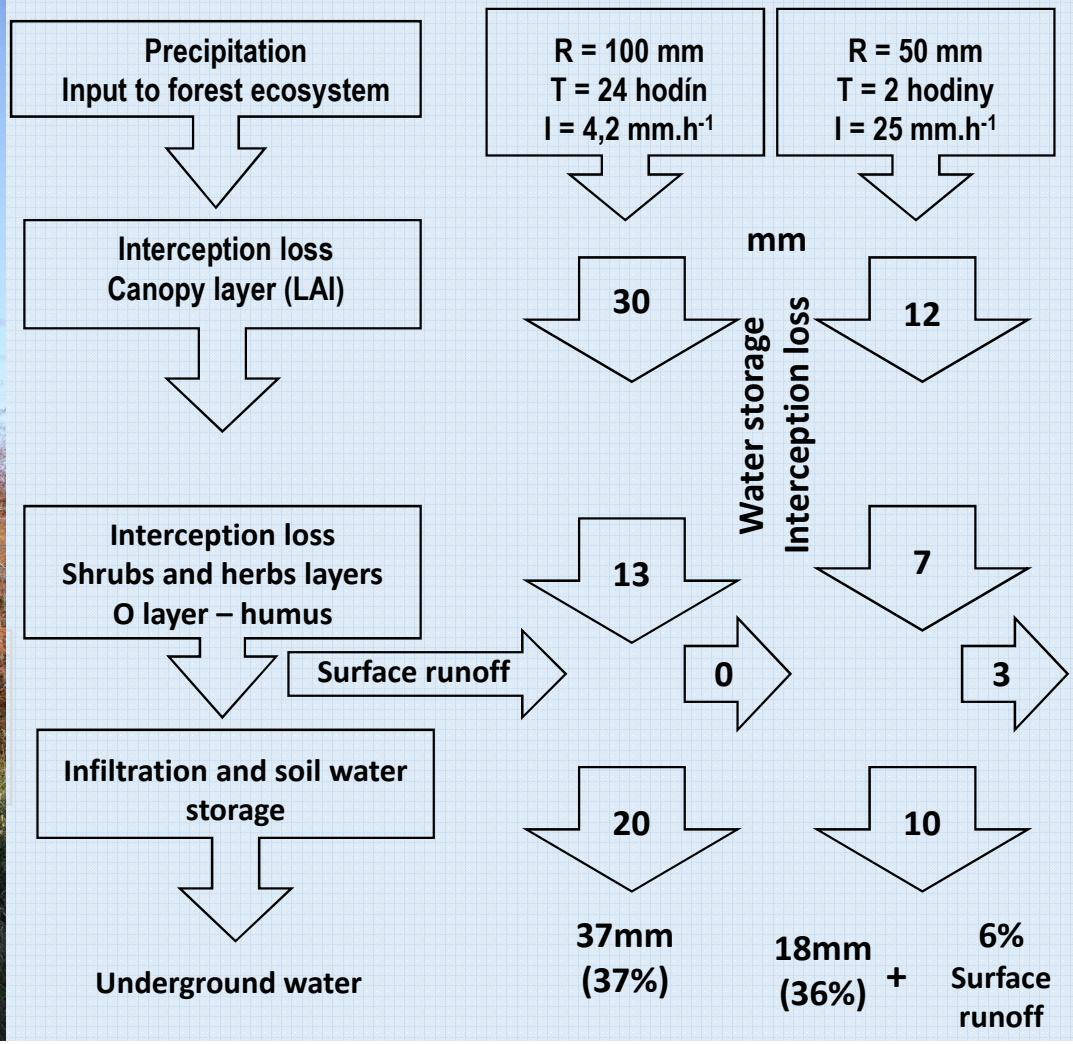
Tree species composition – throughfall changes

- Poľana region
- Mature forests > 90 years old
- Managed forests
- Altitude 850 – 900 m
- Geology – volcanic
- Soils – cambic soils
- Spruce, Fir, Beech

Poľana – 850 m a.s.l.



Rainfall intensity and precipitation transformation

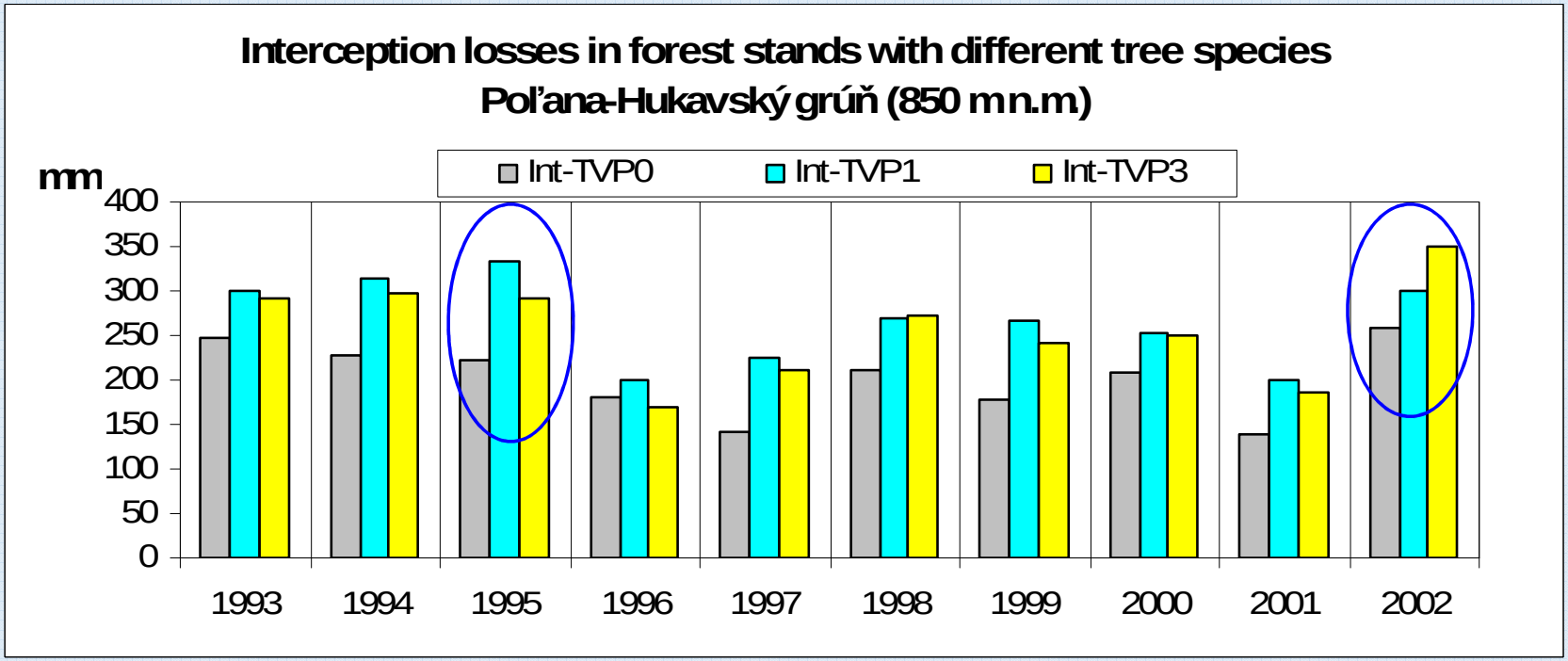


Results – tree species influence

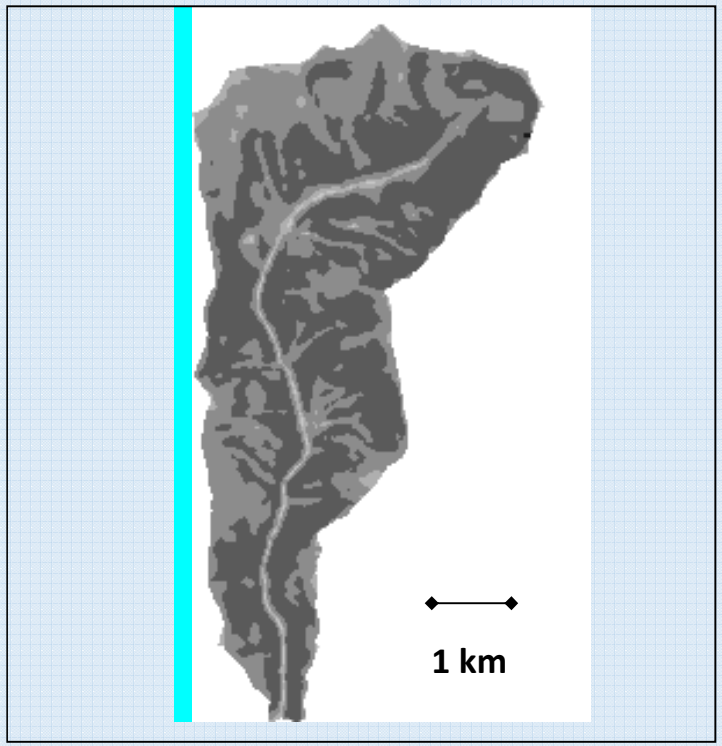
	Regression	Initial interception capacity	R^2
Forest gap	**0,848*VP(mm) - 1,1**	**1,1 mm**	**0,9767**
Beech	**0,780*VP(mm) - 1,6**	**1,6 mm**	**0,9847**
Spruce	**0,739*VP(mm) - 2,3**	**2,3 mm**	**0,9648**
Mixed forest	**0,805*VP(mm) - 2,0**	**2,0 mm**	**0,9843**

Results - tree species influence

TVP0 -mixed forest
TVP1 - spruce forest
TVP2 - beech forest



Forest in small catchments



- **Low Tatras region – Lomnistá dolina**
- **Forest land > 90 %**
- **Managed and protected forests**
- **Altitude 500 – 1900 m**
- **Geology – granite**
- **Soils – cambic soils, podzolic soils**

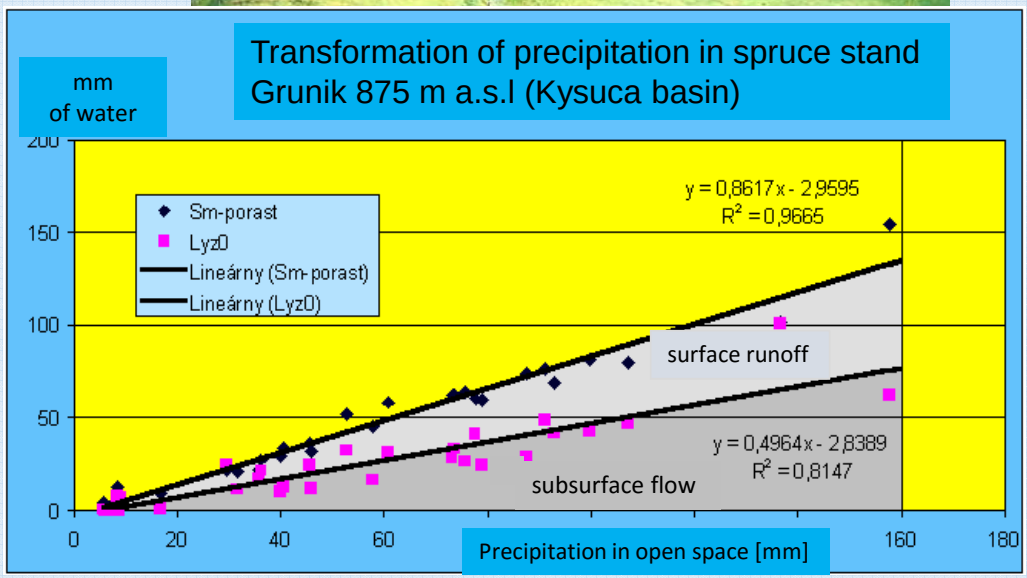
Results – small catchment (Low Tatras Mts.)

- Experimental catchment of 16 km^2
- 7 permanent research plots (1070 – 1450 m a.s.l.)
- Different tree species, different age and structure
- Comparison with standard precipitation measurements 3 km from the catchments

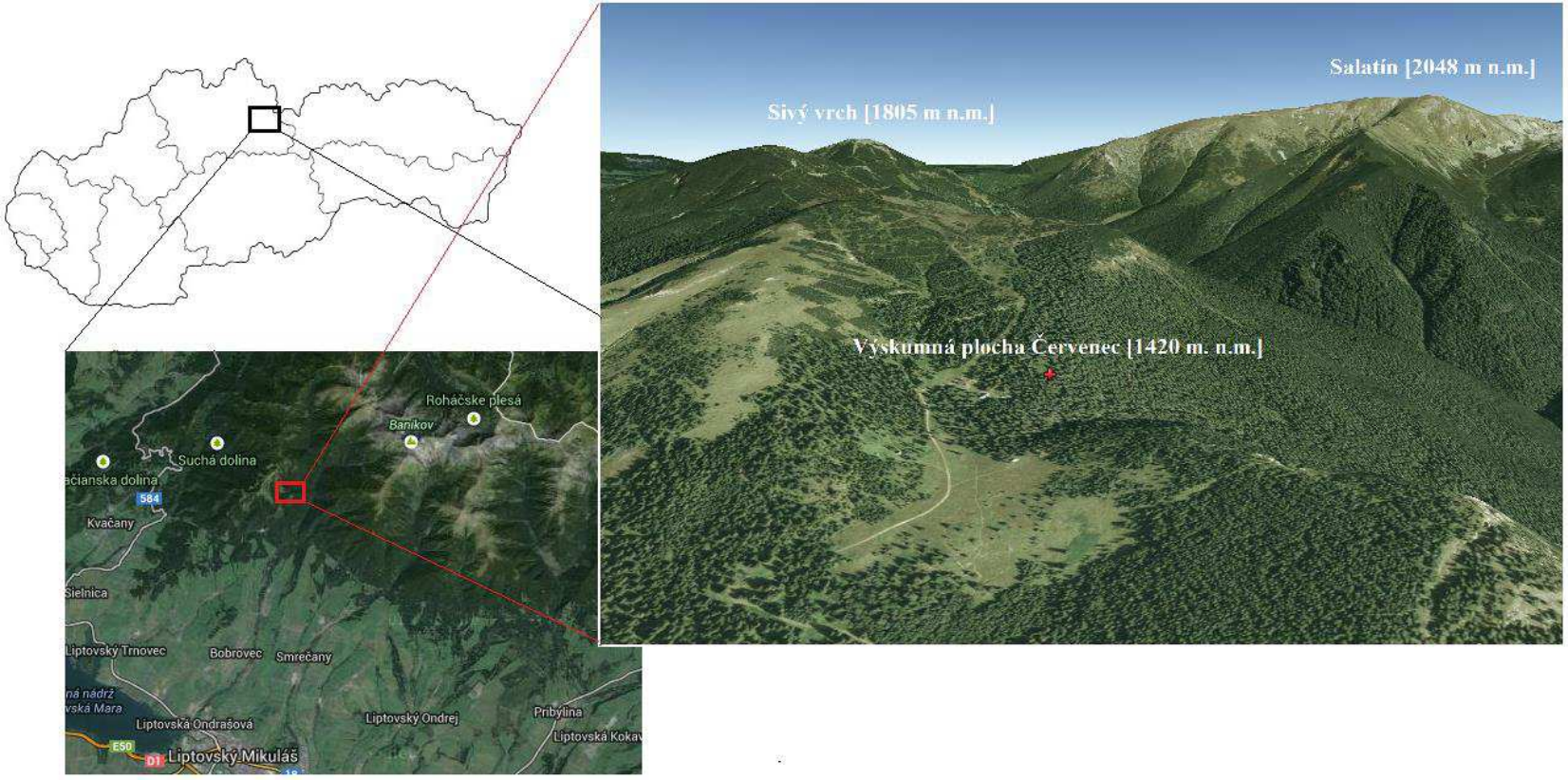
Results – small catchment

Permanent research plots	Altitude m a.s.l.	Interception loss %
Dolný Konštiak	1500	26,1
Horný Konštiak	1450	18,6
TMP L5	1250	38,9
Bosorky - starší porast*	1150	37,2
Bosorky - mladší porast	1100	-10,2
Polianky - starší porast*	1090	41,7
Polianky - mladší porast*	1070	28,8

Transformation of precipitation in TVP Grúnik.



Research area Červenec



Characteristics of research area

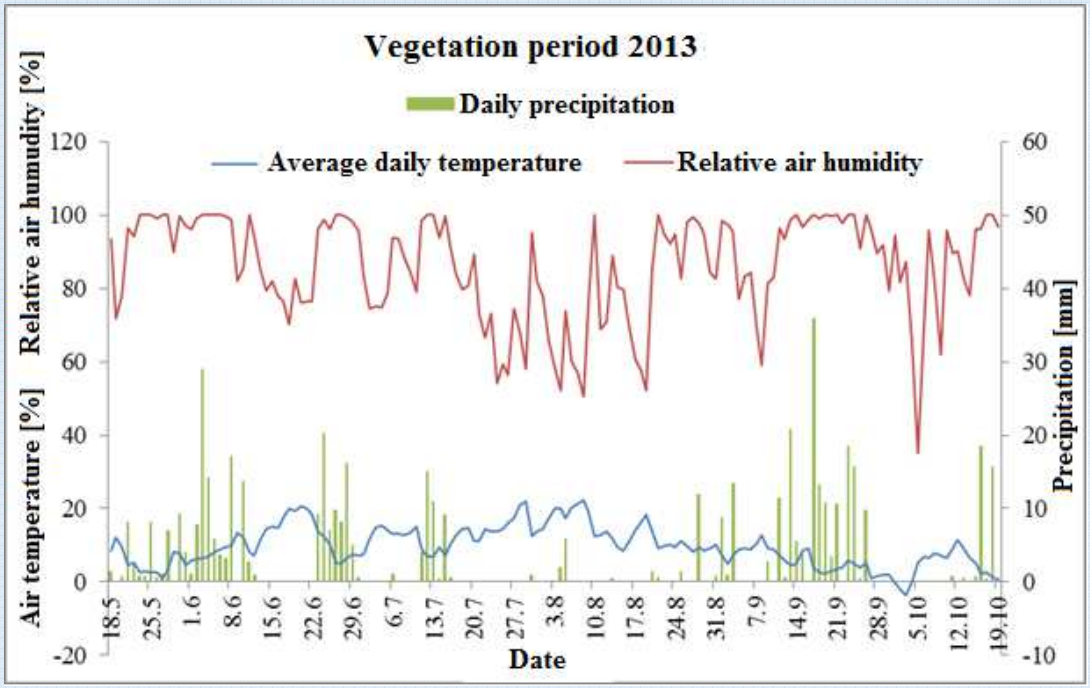
- Border of crystalline and mesozoic rocks with limestone, marlite, claystone and sandstone
- Soils : cambisols, concomitantly rankers and lithosols, cambisolic rendzinas
- Old-growth spruce stand (110 years.) (ρ = 0,6)
- Mean tree height 26,8 m, mean tree diameter 40,5 cm
- July – August 2012 part of research area declined

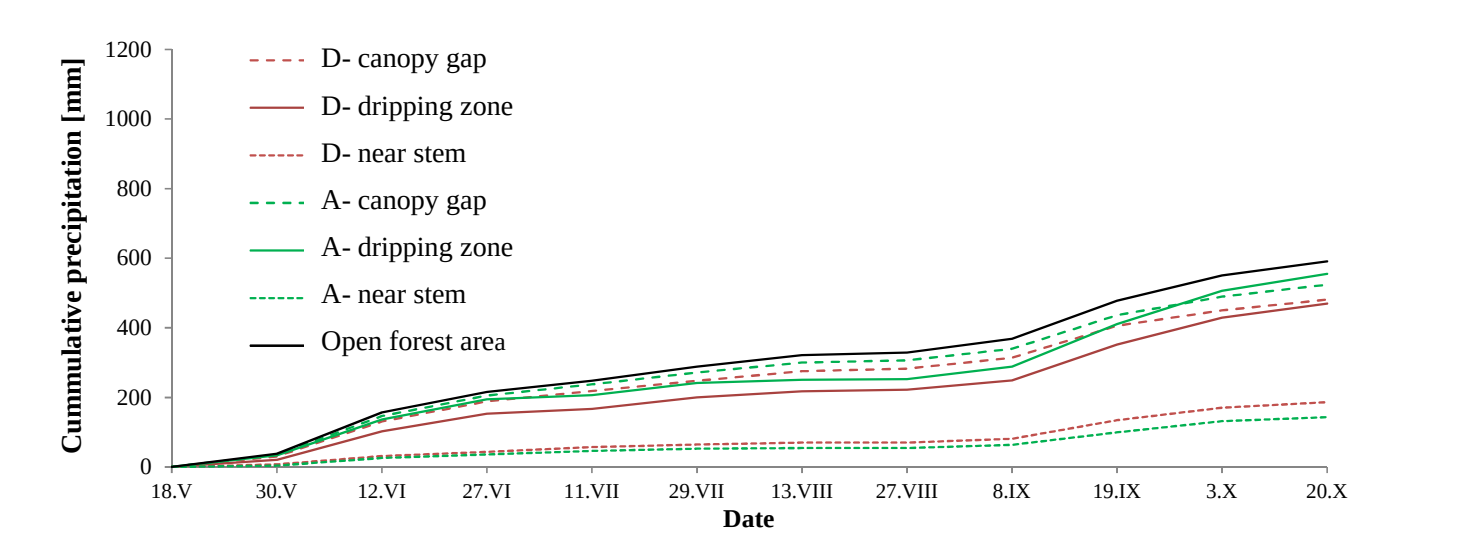
Precipitation measurement

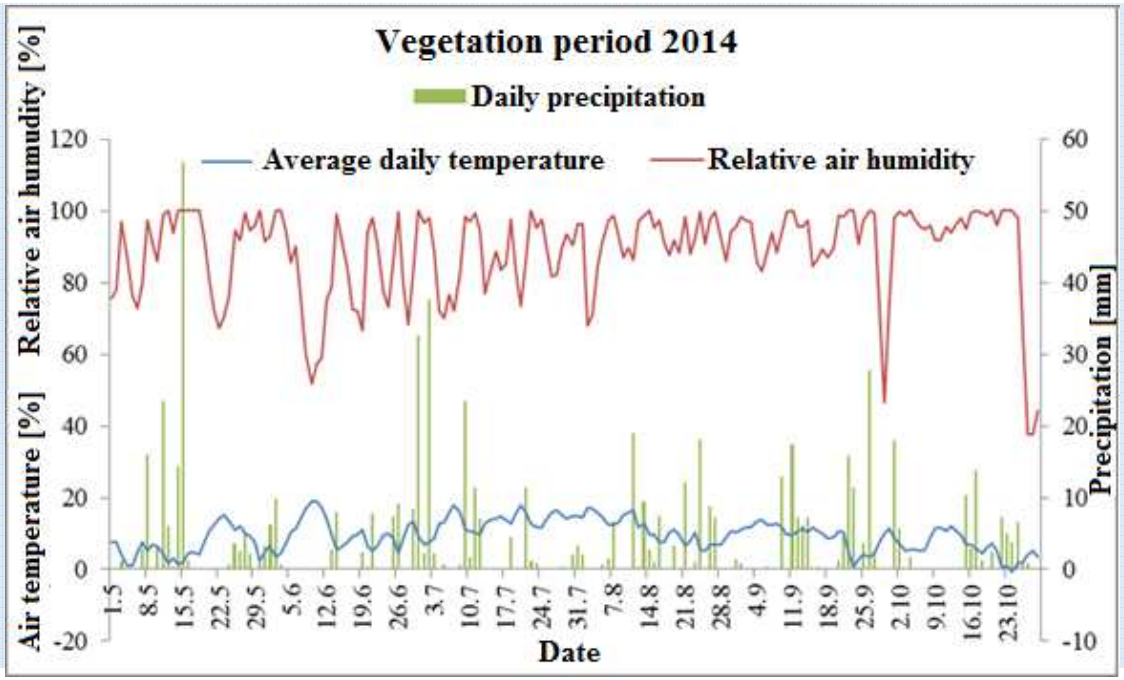
- Dead vs. alive forest
- canopy gap
- dripping zone at the crown periphery
- near stems of the trees

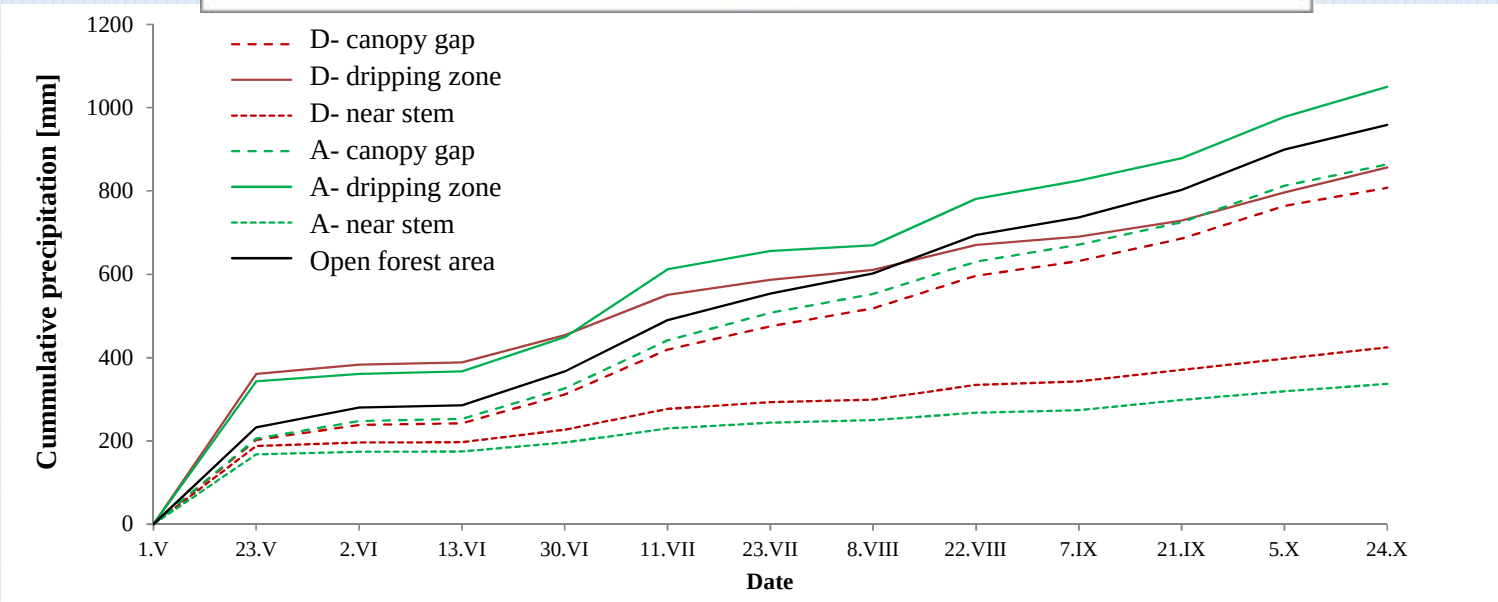
- Open forest area

Results

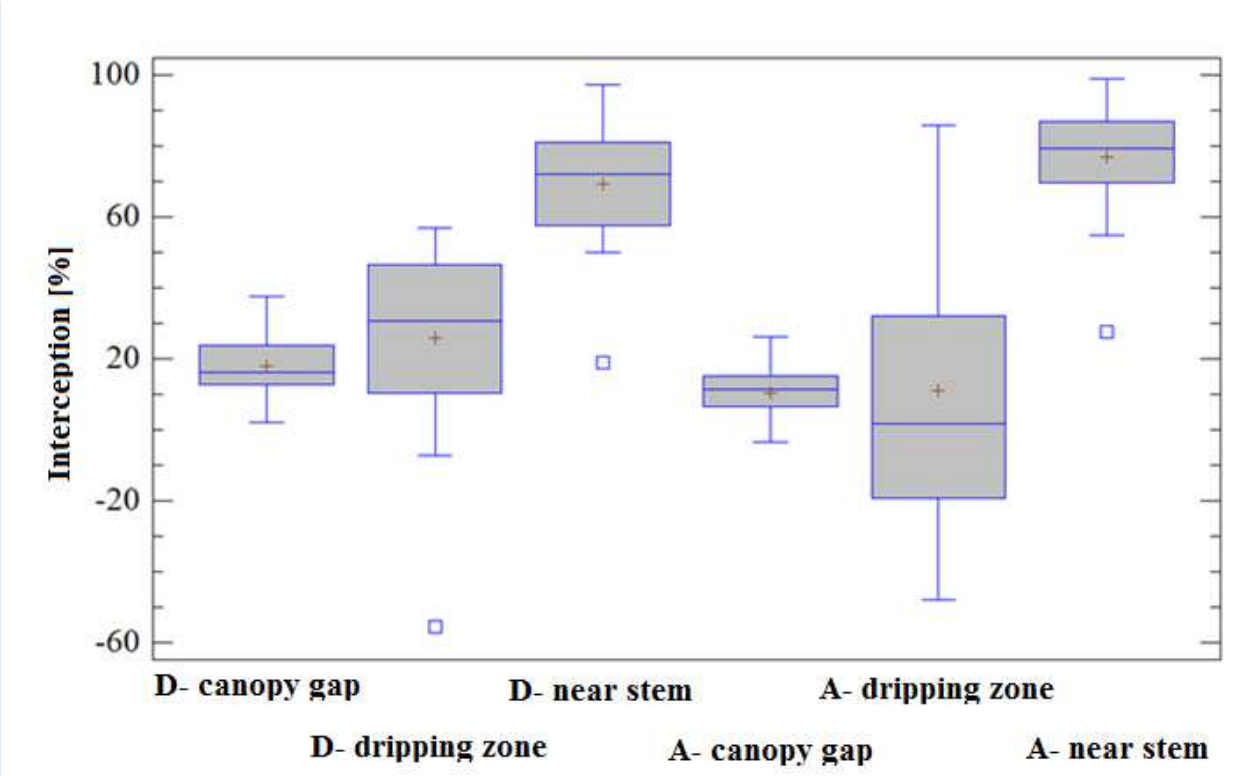

Vegetation period 2013
Daily precipitation
Average daily temperature
Relative air humidity
Air temperature [%]
Relative air humudity [%]
Precipitation [mm]
Date
120
100
80
60
40
20
0
-20
60
50
40
30
20
10
0
-10
18.5
25.5
1.6
8.6
15.6
22.6
29.6
6.7
13.7
20.7
27.7
3.8
10.8
17.8
24.8
31.8
7.9
14.9
21.9
28.9
5.10
12.10
19.10


D- canopy gap
D- dripping zone
D- near stem
A- canopy gap
A- dripping zone
A- near stem
Open forest area
Cummulative precipitation [mm]
1200
1000
800
600
400
200
0
18.V
30.V
12.VI
27.VI
11.VII
29.VII
13.VIII
27.VIII
8.IX
19.IX
3.X
20.X
Date


Vegetation period 2014
Daily precipitation
Average daily temperature
Relative air humidity
Air temperature [%]
Relative air humudity [%]
Precipitation [mm]
Date
120
100
80
60
40
20
0
-20
60
50
40
30
20
10
0
-10
1.5
8.5
15.5
22.5
29.5
5.6
12.6
19.6
26.6
3.7
10.7
17.7
24.7
31.7
7.8
14.8
21.8
28.8
4.9
11.9
18.9
25.9
2.10
9.10
16.10
23.10


D- canopy gap
D- dripping zone
D- near stem
A- canopy gap
A- dripping zone
A- near stem
Open forest area
Cummulative precipitation [mm]
Date
1200
1000
800
600
400
200
0
1.V
23.V
2.VI
13.VI
30.VI
11.VII
23.VII
8.VIII
22.VIII
7.IX
21.IX
5.X
24.X

		Precipitation and interception	**18.V – 20.X 2013**	**1.V – 24.X 2014**	**Sum**
Open forest area		[mm]	591	958,8	1549,8
Canopy gap	**Alive forest**	[mm]	**523,9**	**864,1**	**1388**
	Dead forest		481	807,8	1288,8
	Alive forest	[%]	**11,4**	**9,9**	**10,4**
	Dead forest		18,6	15,7	16,8
Dripping zone	**Alive forest**	[mm]	**554,7**	**1050,4**	**1605,1**
	Dead forest		469,6	856,7	1326,4
	Alive forest	[%]	**6,1**	**-9,6**	**-3,6**
	Dead forest		20,5	10,6	14,4
Near stem	**Alive forest**	[mm]	**143**	**336,8**	**479,9**
	Dead forest		186,1	424,6	610,7
	Alive forest	[%]	**75,8**	**64,9**	**69**
	Dead forest		68,5	55,7	60,6



Locality	p-value				
D- canopy gap vs. D- dripping zone *	0,1283	A- canopy gap vs. A- dripping zone *	0,9233	D vs A canopy gap*	0,0000
D- canopy gap vs. D- near stem**	0,0000	A- canopy gap vs. A- near stem*	0,0000	D vs A dripping zone*	0,0126
D- dripping zone vs. D- near stem*	0,0000	A- dripping zone vs. A- near stem*	0,0000	D vs. A near stem*	0,0000

Conclusions

- It wasn't confirmed that the forest decline cause increase in net precipitation (under canopies) and decrease in interception respectively. (22,3 % and 24,6 %)

- Differences between interception in each locality in dead and alive forest are statistical significant

- Snow accumulation and melting processes are more stable in alive forest

Thanks for your attention