CzechGlobe

24.5.2011
www.czechglobe.cz

The use of regional climate scenario for future risk assessment of spruce forests in Slezské Beskydy Mts.

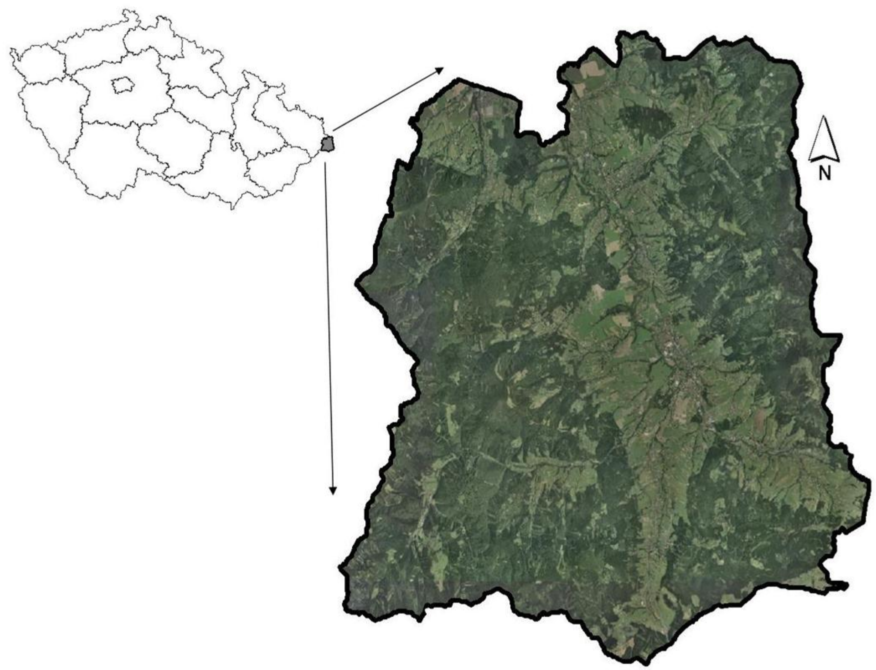
Müllerová T., Štěpánek P., Farda A., Edwards-Jonášová M., Žid T., Čermák P., Křístek Š., Cudlín P.

OP Výzkum a vývoj pro inovace
2007–13
MINISTERSTVO ŠKOLSTVÍ, MLÁDEŽE A TĚLOVÝCHOVY
EVROPSKÁ UNIE
EVROPSKÝ FOND PRO REGIONÁLNÍ ROZVOJ
ŠANCE PRO VÁŠ ROZVOJ

RISK ASSESSMENT DESIGN

- multivariate analysis of relationship between incidental cuttings and site conditions, including climatic factors, of studied area
- monitoring of tree health status on research plots and estimation of adaptation potential
- computation of risk assessment coefficients of forest stand decay using multiply regression on the basis of climatic normal and scenario data
- estimation of subsequent development of given forest stand in next 30 years using stress response module of growth simulator Sibyla

STUDY AREA



→ Natural forest area 40 – Moravskoslezské Beskydy Mts.

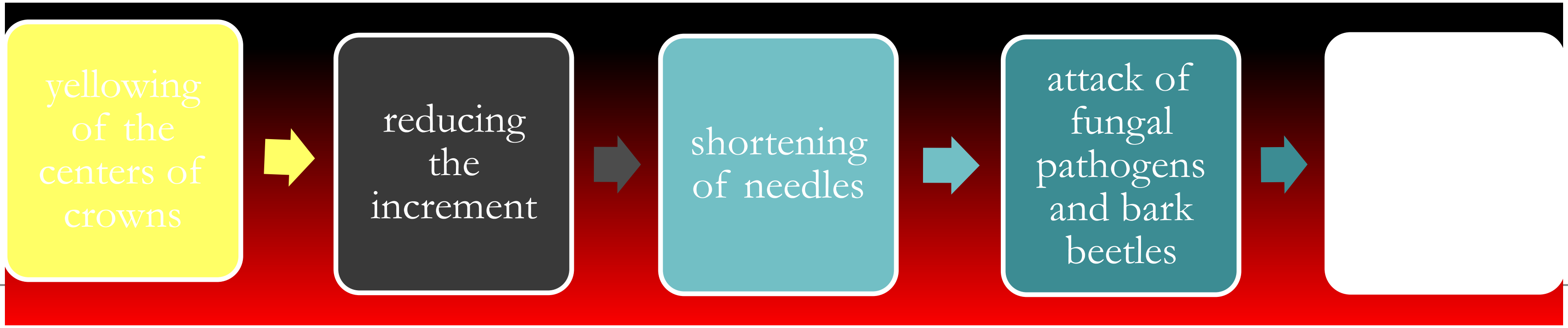
→ Part Slezské Beskydy Mts.

→ Selected forest districts in Forest Administration Jablunkov

Localization of the forest district Jablunkov, (Burešová, 2009).

Problems in study area

- „non-specific forest stand decline”
- inflicted by outstanding needle yellowing, finally resulting in individual tree dying
- these symptoms have been observed in neighbouring forest stands in Slovakia and Poland



1. Multivariate analysis of relationship between incidental cuttings and site conditions, including climatic factors

Data:

- Incidental fellings from the period of 1999 - 2008 in m^3ha^{-1}
- Altitude, exposition and inclination of a forest stand division (DEM)
- Forest type and forest stand age (FMP)
- Basic climate characteristics, Climate extremes T30, 10D

Processing:

- Multivariate methods of Canoco programme - Redundancy analysis (RDA)
- Independent variables - forest type, stand characteristics, climate data and year of felling

Processing climate characteristics

• Calculation of temperature or precipitation field - on the basis of spot observation and its regresion dependence on the altitude.

• For calculation - used technical series of stations, original station series were analysed according quality control, homogenization and mising values were completed.

• Value interpolation of climate parameters for the area was done with use of linear kriging (number of used points 12; minimal number of observations used for regresion – 5; size of rastr cell – 500 m).

•Interpolation were done every month, winter (December to February), growing period (April to October) and year in the period 1961–2007.

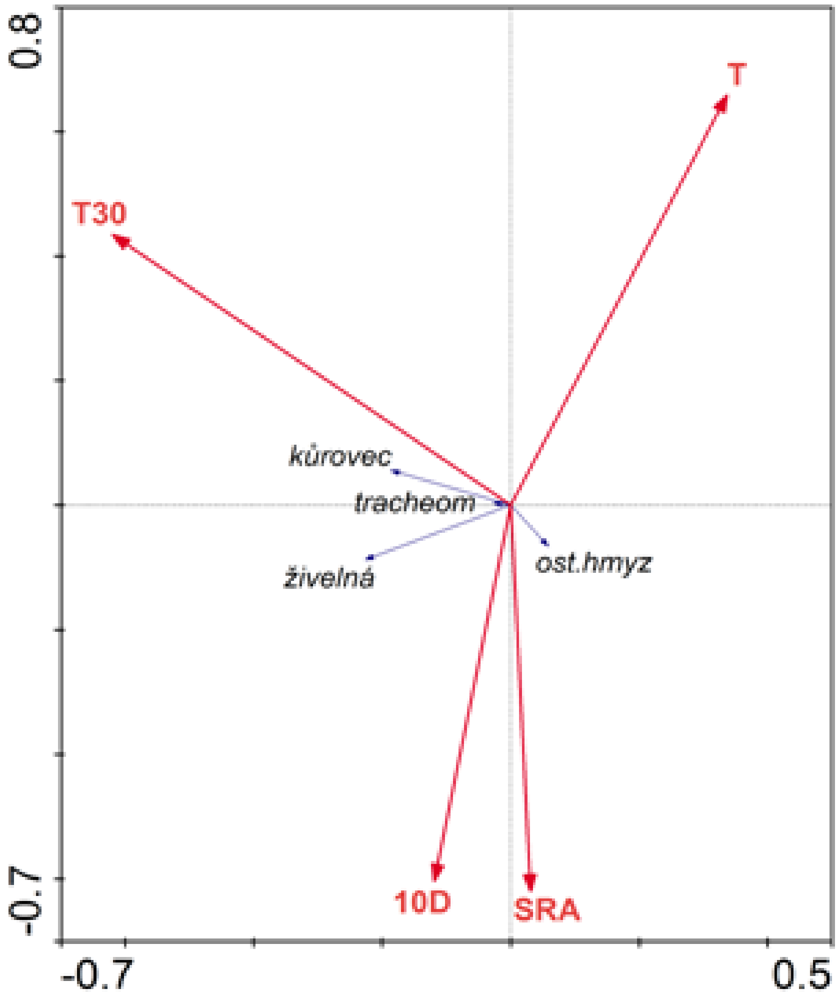
Climatic modelling

- Global climatic model **ARPEGE-Climat**, used in Meteo-France, served as a source for **Model ALADIN-Climate/CZ**.
- On the basis of 131 grid points, obtained from **Model ALADIN-Climate/CZ** and above mentioned, homogenous and completed station series there were calculated new technical series in the selected points.
- Emission scenario of greenhouse gases **IPCC SRES A1B** (slightly non-favourable alternative) was selected.
- Integrated domain covered Middle Europe in the period of 1961 - 2010, model discrimination **25x25km**, temporal step 900 s.

RESULTS:

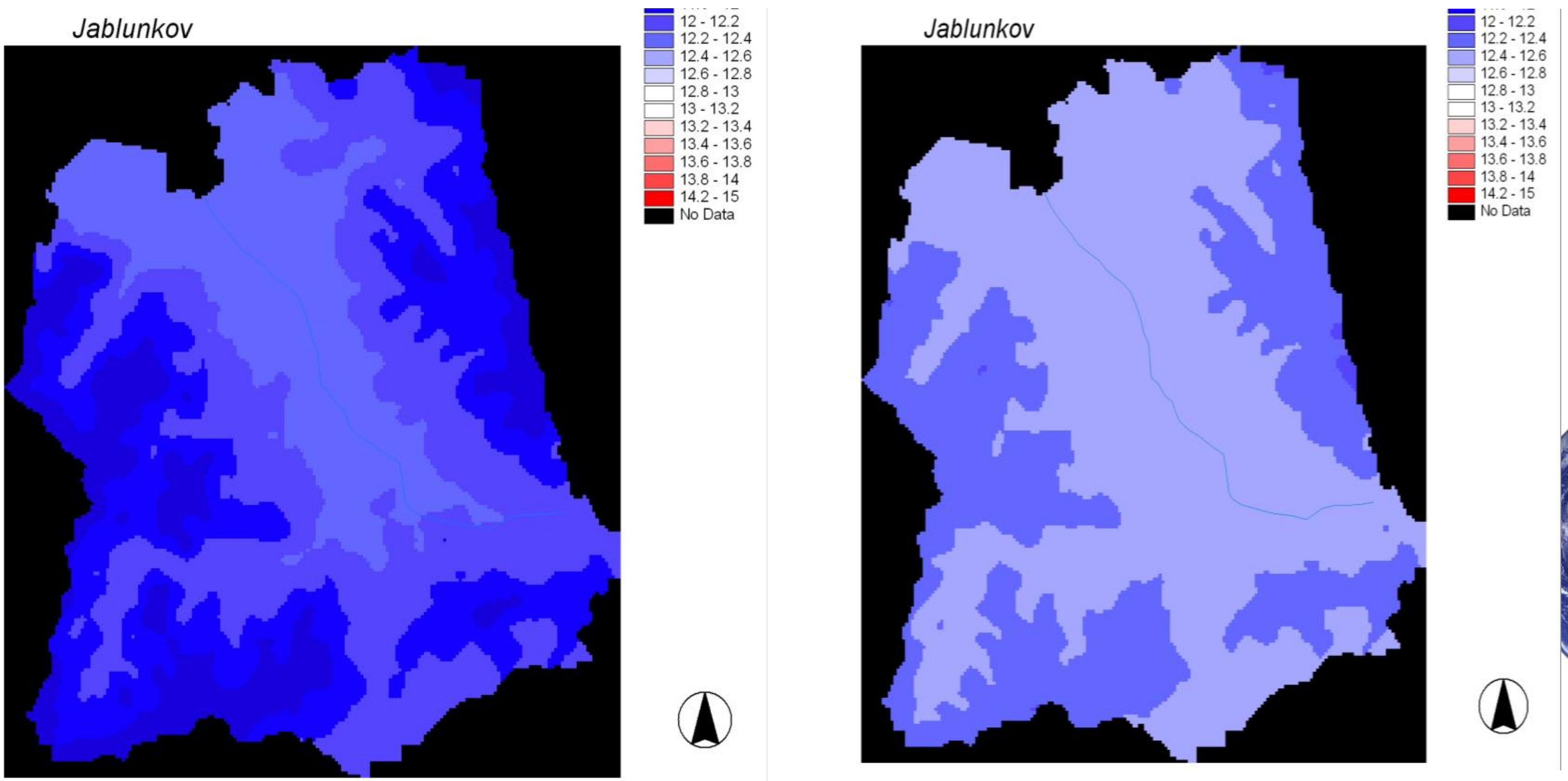
Independent variables	Explained variability (%)	Explained variability 1. axis (%)	p
Forest type	10.5	9	0.002
Forest site characteristics	8.2	7.6	0.002
Climate data	3.7	3.2	0.001
Year	16.5	8.7	0.001

Results of RDA analysis for the particular groups of independent variables.

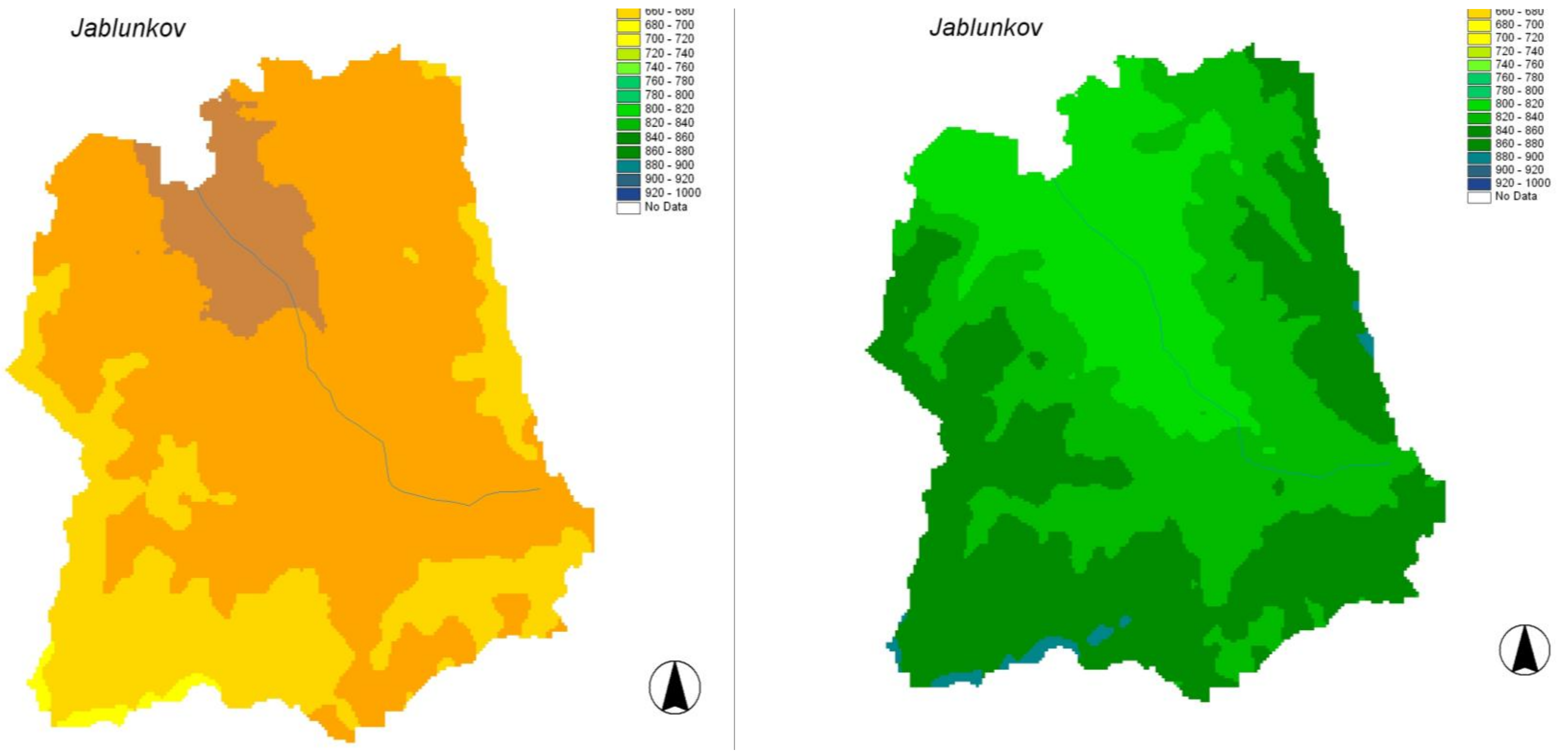


→ **positive relationships among** **bark-beetle outbreak and T30 value** **and among** **natural disasters and number of episodes, when daily precipitation was less than 1mm for 10 days**

RDA – occurrence of incidental felling (bark beetle, natural risks, other insects, tracheomycosis and root rot) in relation to climatic factors.



Average daily temperatures at the area of the Jablunkov Forest District in the vegetation period 1960-1990 and 2010-2050.



Average precipitation sums at the area of the Jablunkov Forest District in the vegetation period 1960-1990 and 2010-2050.

2. Monitoring of tree health status on research plots and estimation of adaptation potential

Stress response categories		Total defoliation [%]		Percentage of secondary structure [%]	
1	Resistant trees	≤ 35	slightly damaged	≤ 50	lowly to medium transformed
2	Resilient trees	≤ 35	slightly damaged	> 50	heavily transformed
3	Damaged & lowly transformed trees	≥ 40	medium to heavily damaged	≤ 50	lowly to medium transformed
4	Damaged & heavily transformed trees	≥ 40	medium to heavily damaged	> 50	heavily transformed

lobe

POTENTIAL FOR RESISTANCE	% of dead trees	% of damaged trees	current status of stand	subsequent stand development in 40 years	probability of decay of vegetation within 40 years *
A	0%	< 10%	≥ 50% resistant trees	≤10% trees will die within 40 years	0,2
B	< 10%	10% ≤50%	≥ 10% damaged & heavily transformed trees	health deterioration, progressive tree death, stand decay > 40 years, 10-40% individually trees will die within 40 years	0,5
C	>10-30%	> 50%	individually trees death; gaps in the stand > 0,01ha	stand decay in 6-40 years	0,9
D	>30-50%	≥ 70%	gaps in the stand > 0,04 ha	stand decay in 4-5 years	1
E	≥ 50%	≥ 90%		> 50% trees will die within 3 years	1

* stand decay = ≥ 50% of dead trees

Category of stress response				Regenerative potential	Potential for resistance
1	3	2	4		
60-70%	40-30%	< 10%	NO	I.	A
40-60%	60-40%	>10%	NO	II.	A (B*)
			YES	III.	B
		< 10%	NO	IV.	A (B*)
			YES	V.	B
30-40%	70-60%	>10%	NO	VI.	A (B*)
			YES	VII.	B
		< 10%	NO	VIII.	B

Determination of the regeneration potential and potential for resistance.

RESULTS:

Regeneration potential	Total defoliation [%]	Defoliation of the primary structure [%]	Percentage of secondary structure [%]	Stress response categories [%]			
				1	2	3	4
I	32,69	48,60	23,05	78,10	1,67	19,05	1,19
III	36,50	61,75	39,25	38,10	9,52	42,86	9,52
IV	36,50	45,63	15,88	52,50	0,00	47,50	0,00
V	35,04	55,61	31,84	62,69	0,00	28,68	8,63
VII	44,58	65,83	39,58	8,33	8,33	66,67	16,67
VIII	39,17	53,75	24,17	25,00	0,00	75,00	0,00

FD Jablunkov, Slezské Beskydy Mts.

3. Computation of risk assessment coefficients of forest stand decay using multiple regression on the basis of climatic normal and scenario data

Data:

- DEM, FMP, Zones of exposure, Landsat satellite images, Personal field survey and geo-statistical assessment

- Independent variables – Forest altitudinal zone,Trophic and Hydric level, Insoltion, Norway spruce representation, Forest stand age, Vertical forest stand structure, Canopy closure, Initial damage, Pollution load, % felling, % abiotic and biotic risk, Health status

Processing:

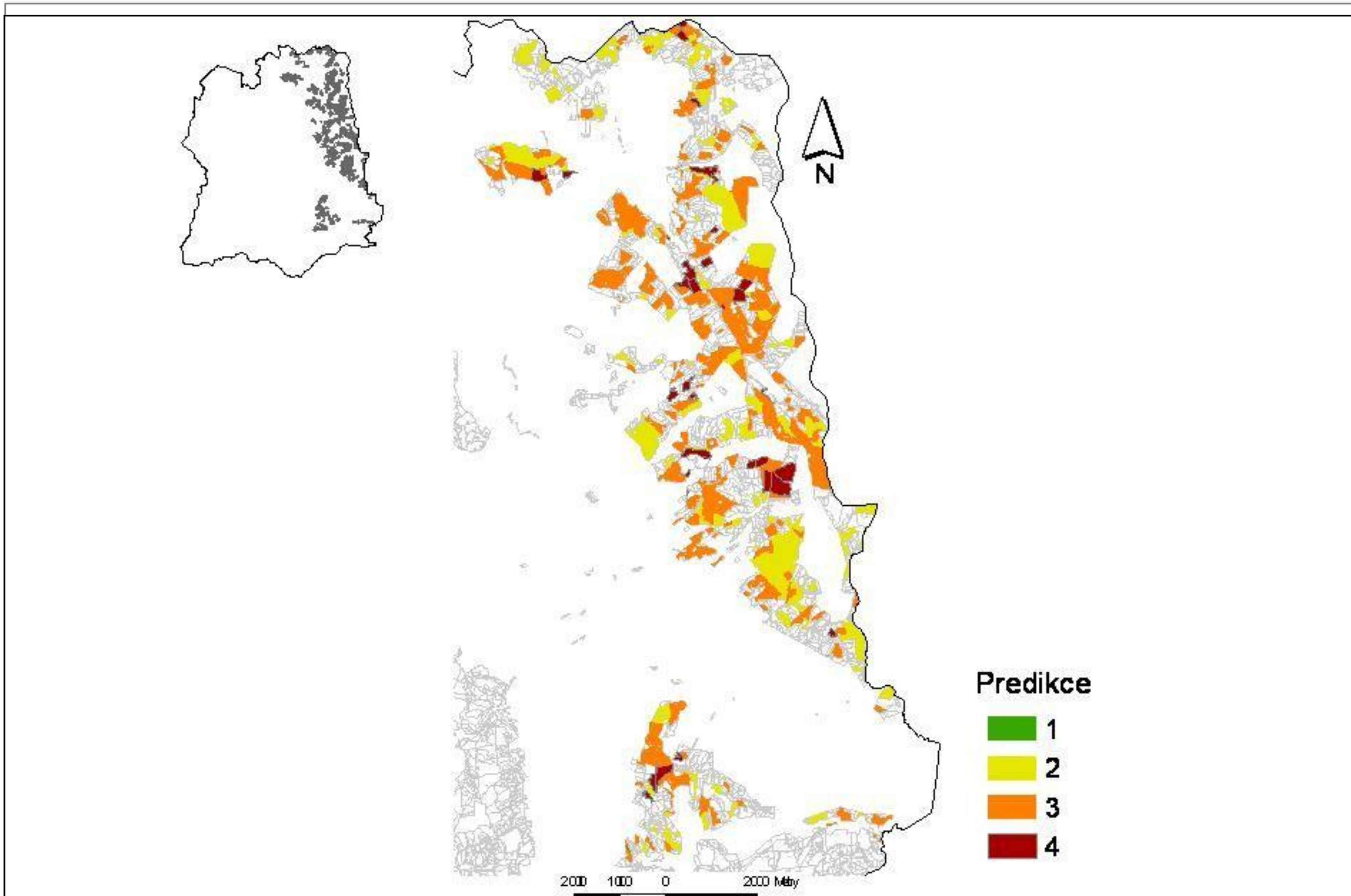
- Multiple regression with the gradual selection of significant explanatory variables - forward stepwise (Statistica 6.0 programme)

- Dependent variable – % of damaged trees

RESULTS:

Includes variables	Regression coefficient	Beta	p
Absolute term	0,4919		0
Canopy closure	-0,016	-0,1164	0,02
Hydric level	-0,0147	-0,1427	0,01
Initial damage	0,0541	0,1486	0
% felling	0,0009	0,1388	0,01
Health status	-0,0296	-0,1091	0,04

Test of regression model: $R2 = 0,0826$, $F = 6,539$, $p = 0,000008$

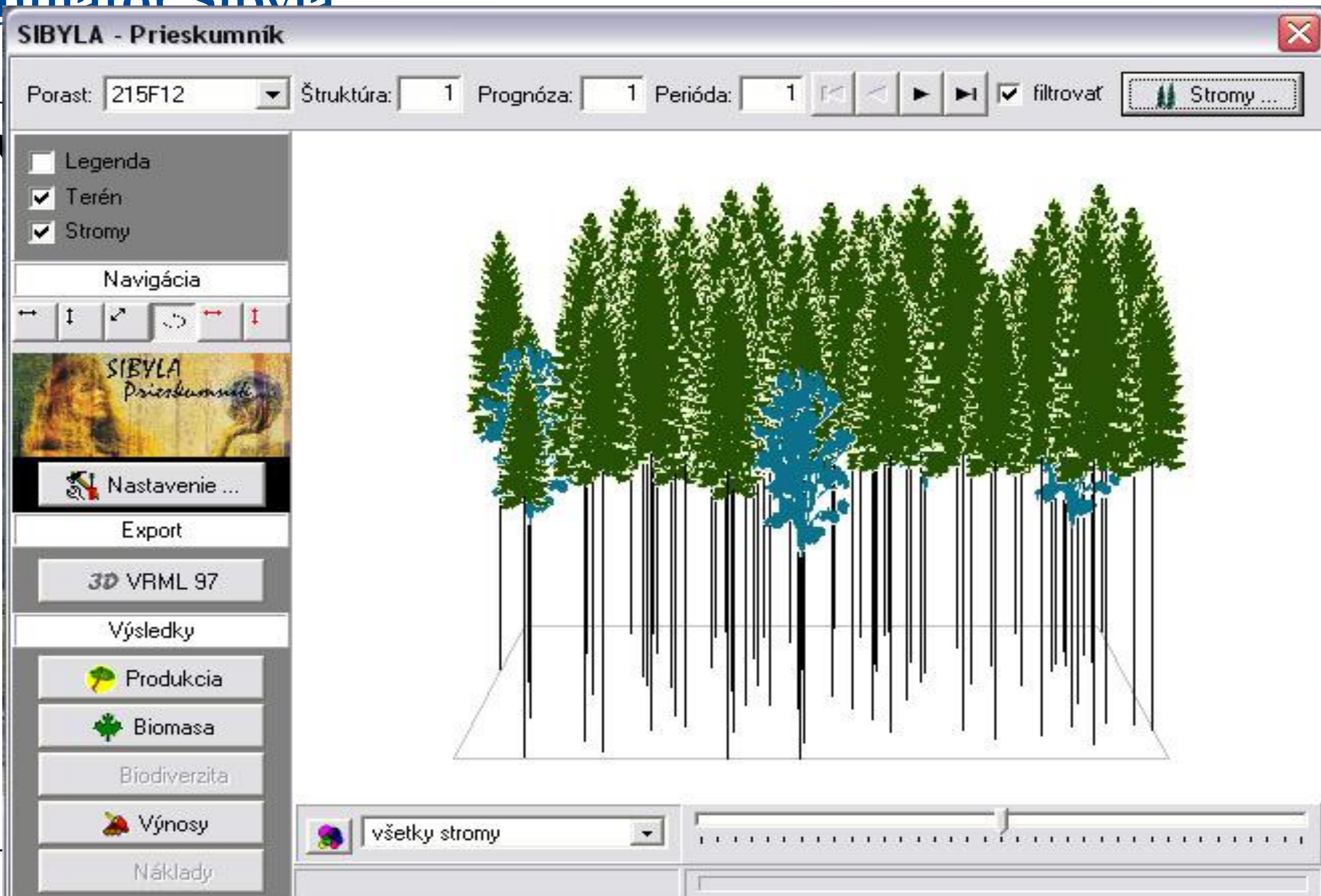


Propability predictions 1 - 4 (1: 0-10%, 2: 11-30%, 3: 31-60%, 4: 61-100%) in FD Nýdek and Písek, (Burešová, 2009).

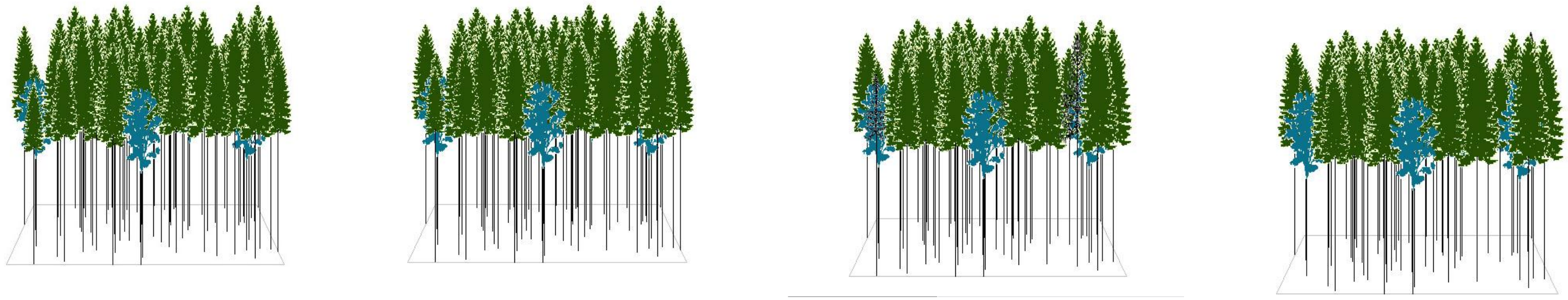
4. Estimation of subsequent development of given forest stand in next 30 years using stress response module of growth simulator Sibyla

Da

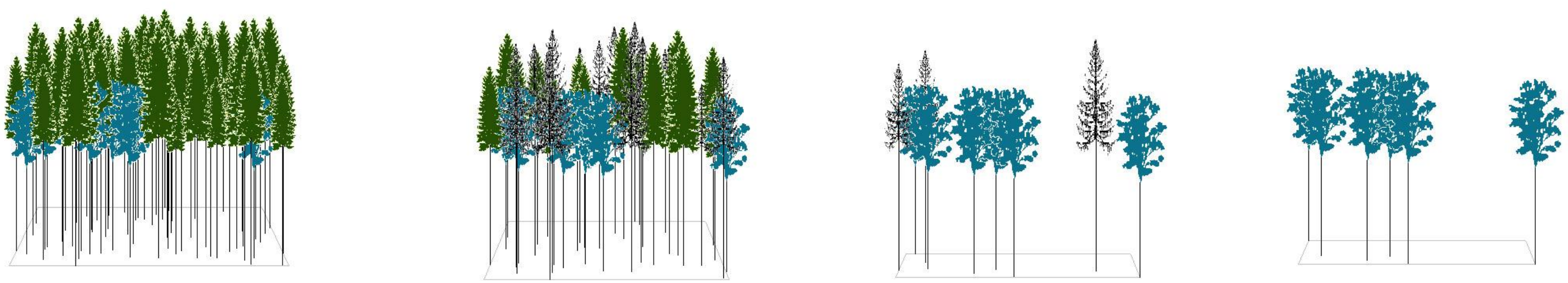
- ...tor
- ...f
- ...tors)
- ...t of a



YEAR 2010 2020 2030 2040



Prediction of particular stand FD Jablunkov - potential damage 0.20 ↑ and 1,00 ↓.



YEAR 2010 2020 2030 2040

RESULTS:

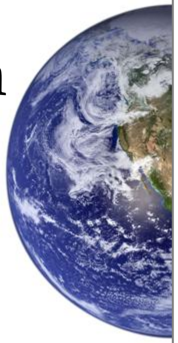
Year	Stand age(t)	Diameter (d)	Height (h)	Form factor (f)	Medium volume (v)	Number of trees (N/ha)	Circular stand b.a. (G/ha)	Volume (V/ha)	h/d
2010	120	48.7	37.02	0.408	2.81093	260	48.4	731	0.76
2015	125	50.5	37.5	0.404	3.03646	132	40294	401	0.743
2020	130	49.9	36.97	0.405	2.93013	60	40370	176	0.741
2025	135	52.5	38.07	0.392	3.23279	12	40331	39	0.725
2030	0	0	0	0	0	0	0	0	0
2035	0	0	0	0	0	0	0	0	0
2040	0	0	0	0	0	0	0	0	0

Prediction of particular stand FD Jablunkov - potential damage 0.20 and 1,00.

CONCLUSIONS

- New method for future risk assessment of spruce forests was proposed and verified on data from the Slezské Beskydy Mts.

- Data from regional climate scenario, provided in the net 25 x 25 km, cannot be used for “regional studies“ without downscaling.



- In the area of the Slezské Beskydy Mts. Norway spruce will not be able to grow and carry out all ecosystem services as it has done up to now.

Thank you for your attention!