

Terrestrial laser scanning on the Slovak side – methodology and results

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scientific seminar
Remote Sensing In Forest Protection And
Forest Inventory



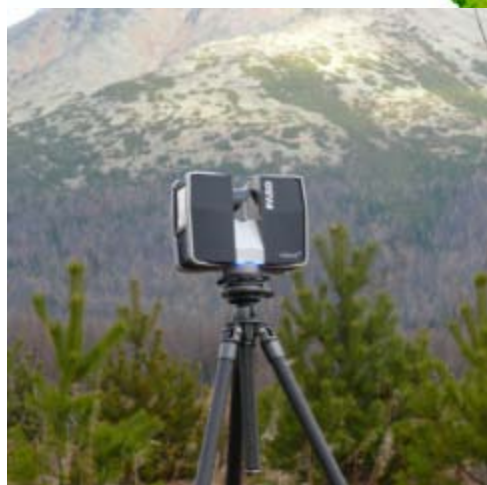
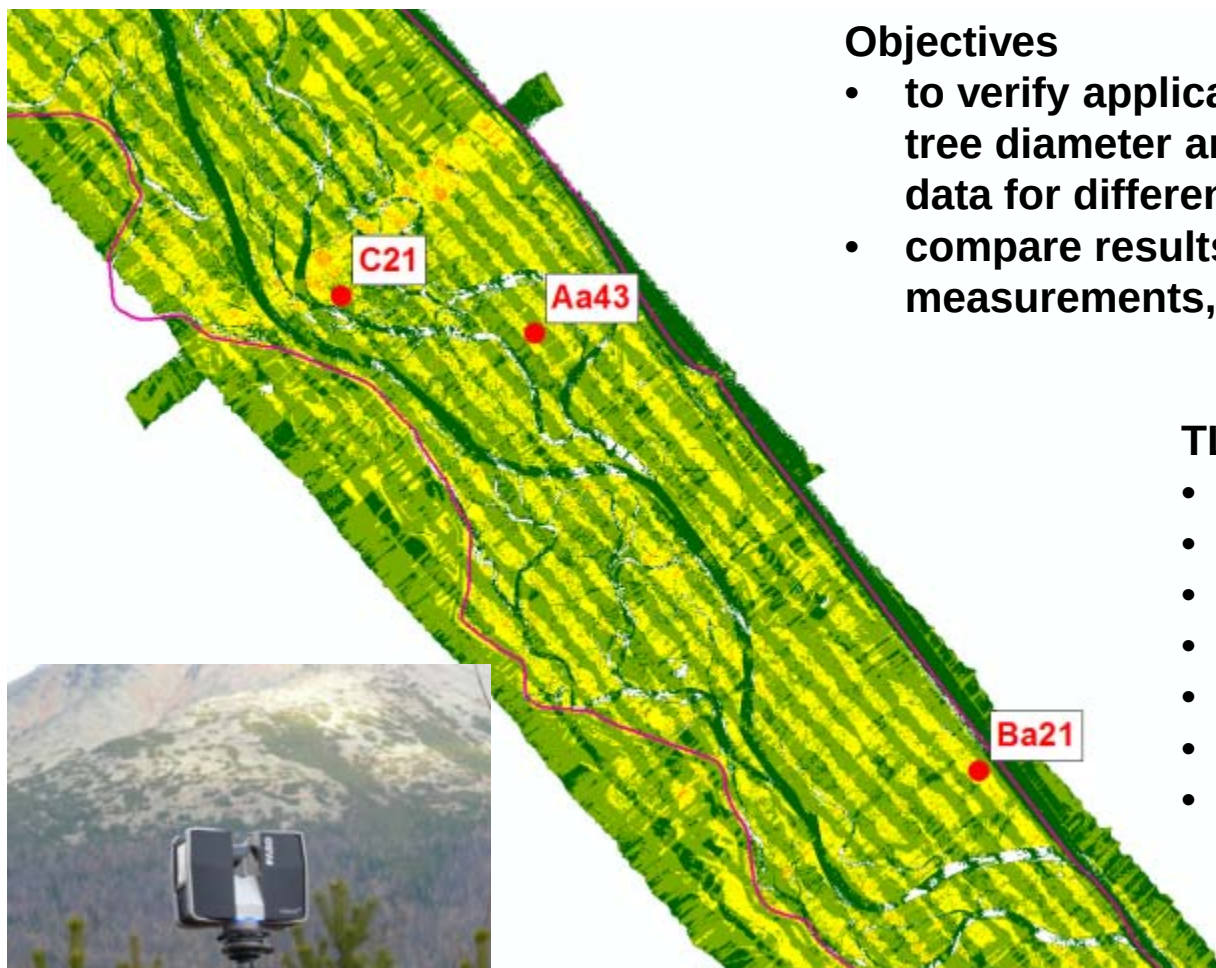
INMEIN research plots for TLS

Objectives

- to verify application of derivation of tree diameter and tree height from TLS data for different tree species
- compare results from field measurements, ALS and TLS

TLS data processing:

- Georeferencing
- 3D visualization
- DEM (2m, 1m, 0,5m)
- Horizontal cross-sections
- Identification of trees
- Tree diameter
- Tree height



- FARO Focus 3D
- FARO Scene
- 3DT TLS

INMEIN research plots



Plot Aa43

Hybrid poplar
(*Populus robusta*)

Radius: 16m

Number of trees: 41

Age: 18

d : 18 - 40cm

h : 11 - 38m

05.12.2013

INMEIN research plots



Plot Ba21

White willow
(*Salix Alba*)

Radius: 20m

Number of trees: 44

Age: 18

d : 20 – 45cm

h : 17 – 28m

11.03.2014

INMEIN research plots



Plot C21

European ash
(*Fraxinus excelsior*)

Radius: 16m

Number of trees: 130

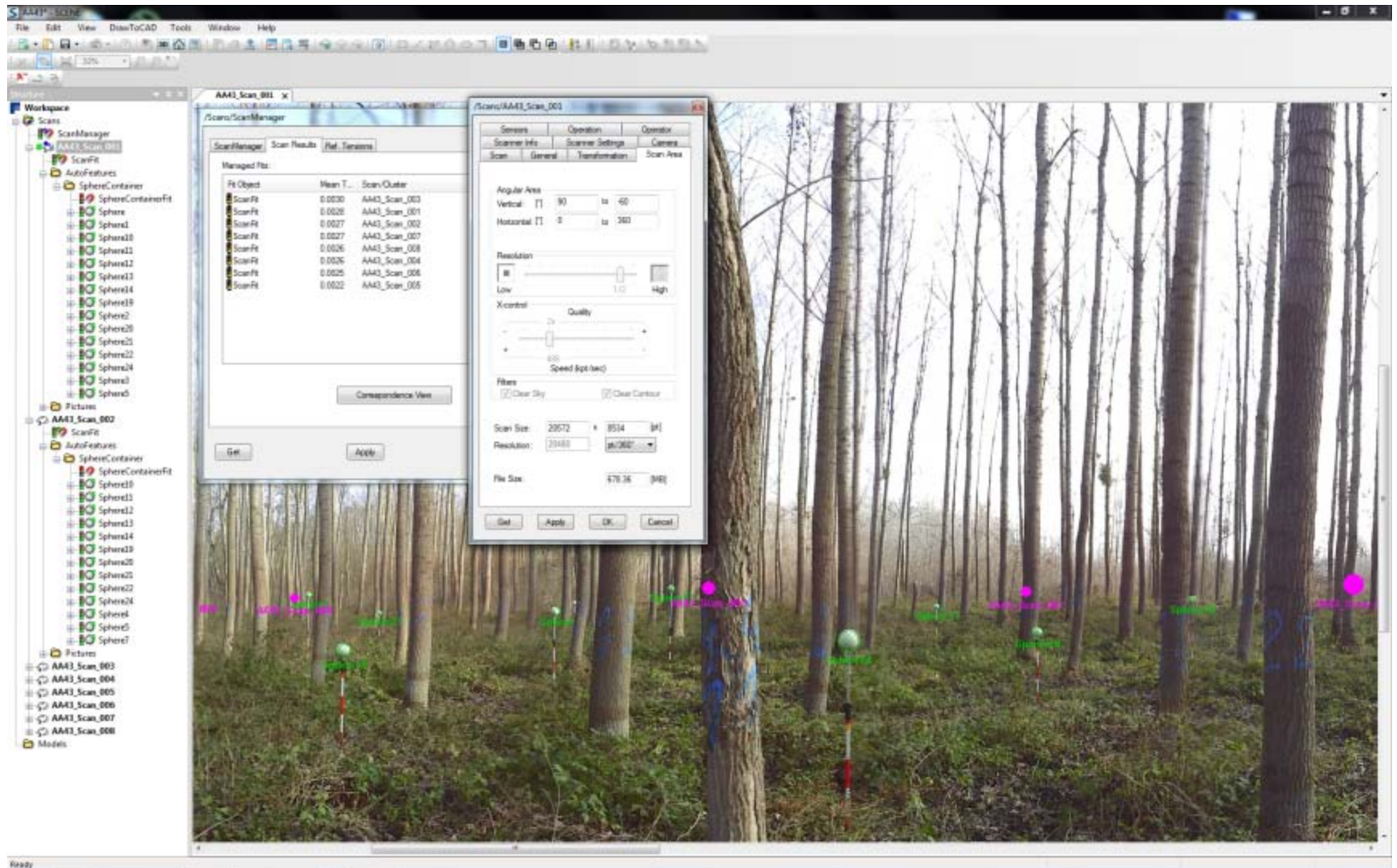
Age: 23

d : 10 – 30cm

h : 10 – 28m

25.03.2014

INMEIN Research plot AA43

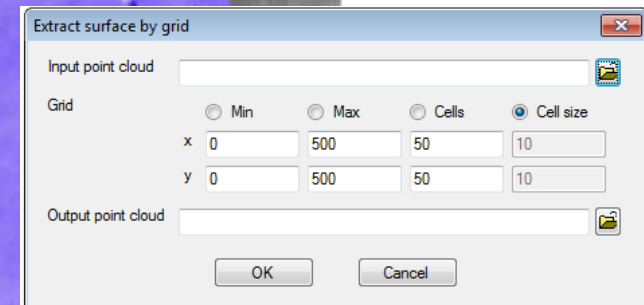
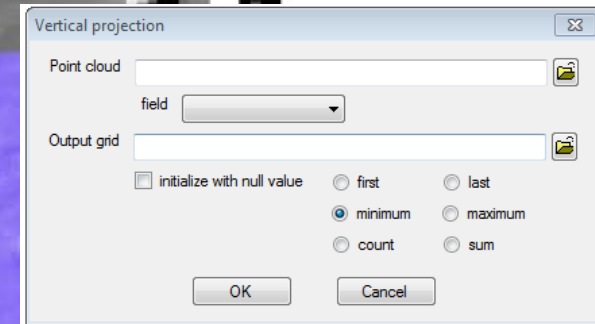


Digital elevation models

1,0 m

0,5 m

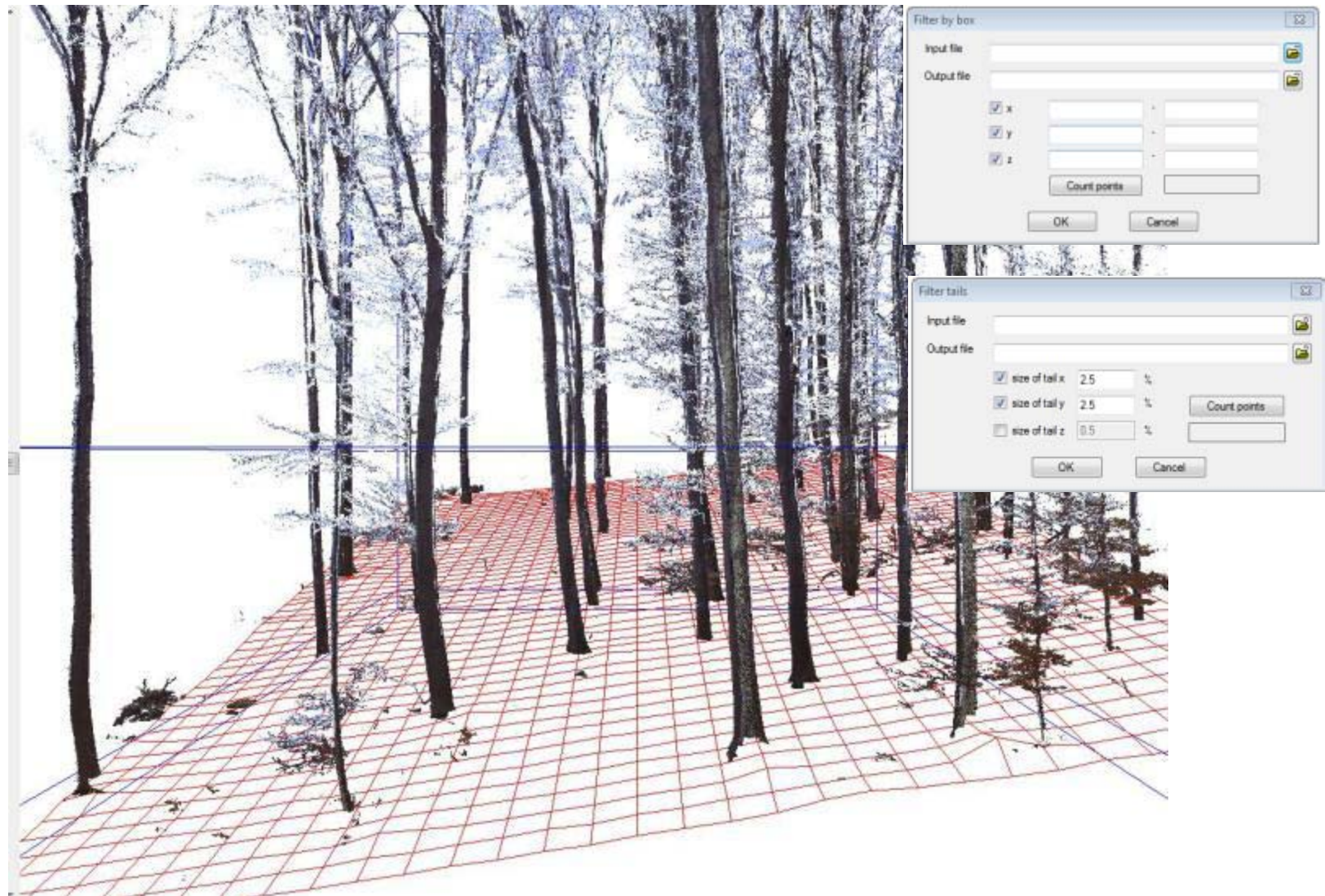
0,1 m



Segmentation



Segmentation



Tree identification

Surface cross-section

Input file

Output file

☐ x -

☐ y -

Surface

relative height -

OK Cancel

Group by distance

Input point cloud

Output point cloud

☒ 2D ☐ 3D

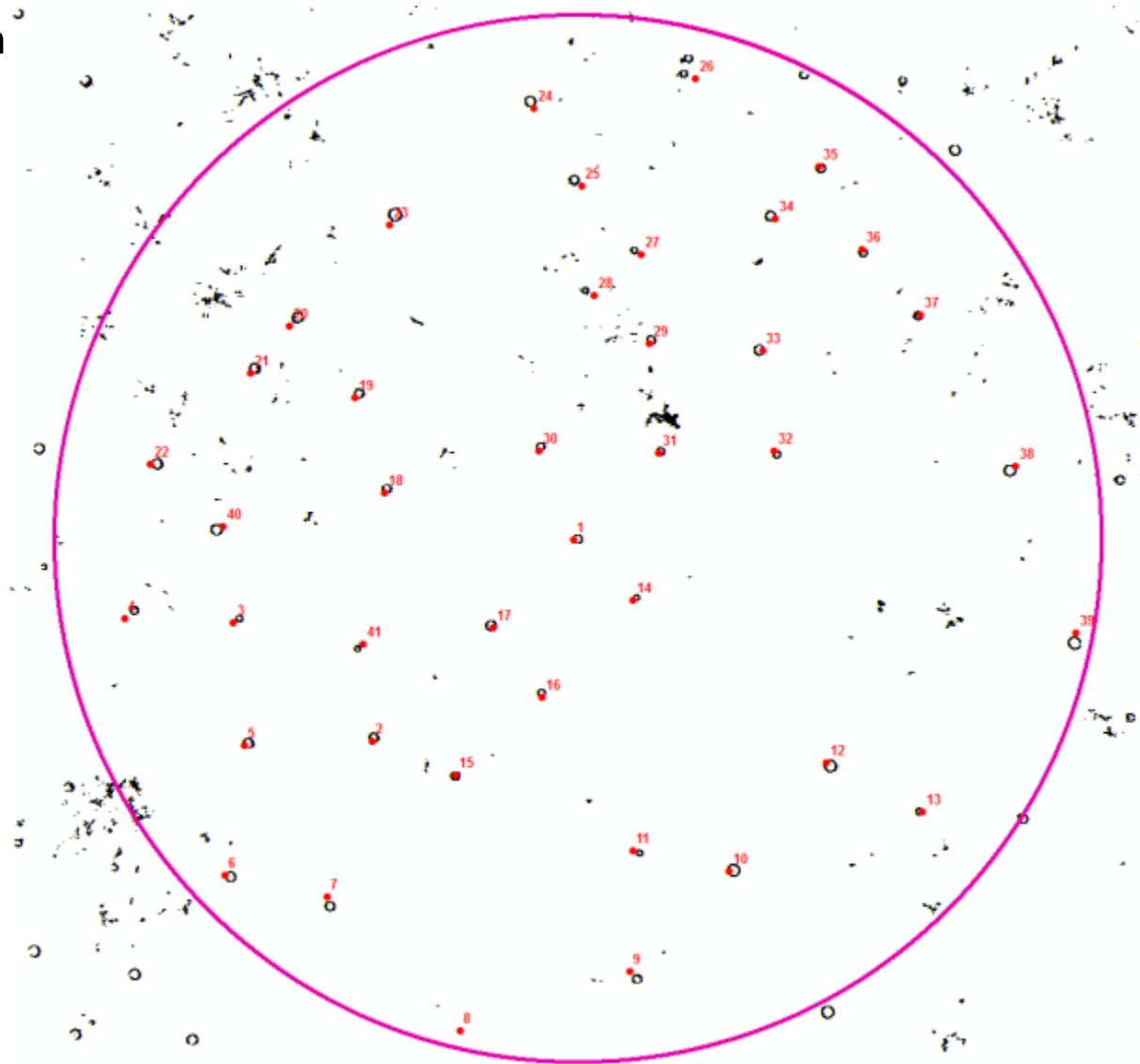
Maximal distance

Minimum points

OK Cancel

INMEIN research plot AA43

Identification
of trees
(FieldMap)



3D and 2D visualization



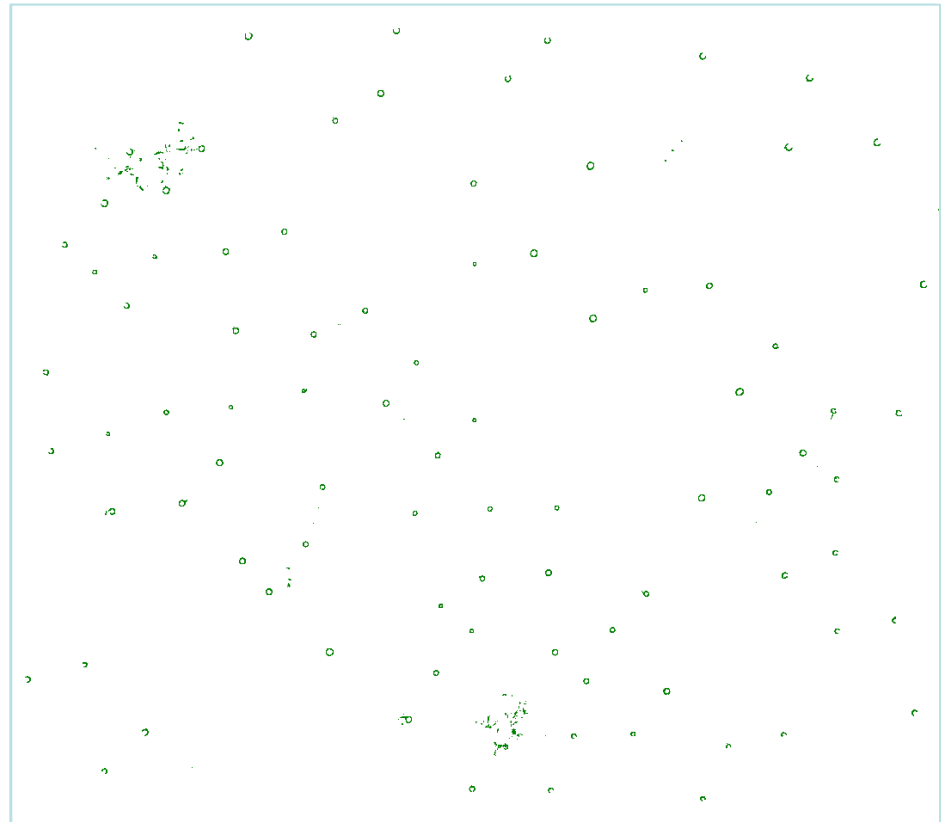
Aa43



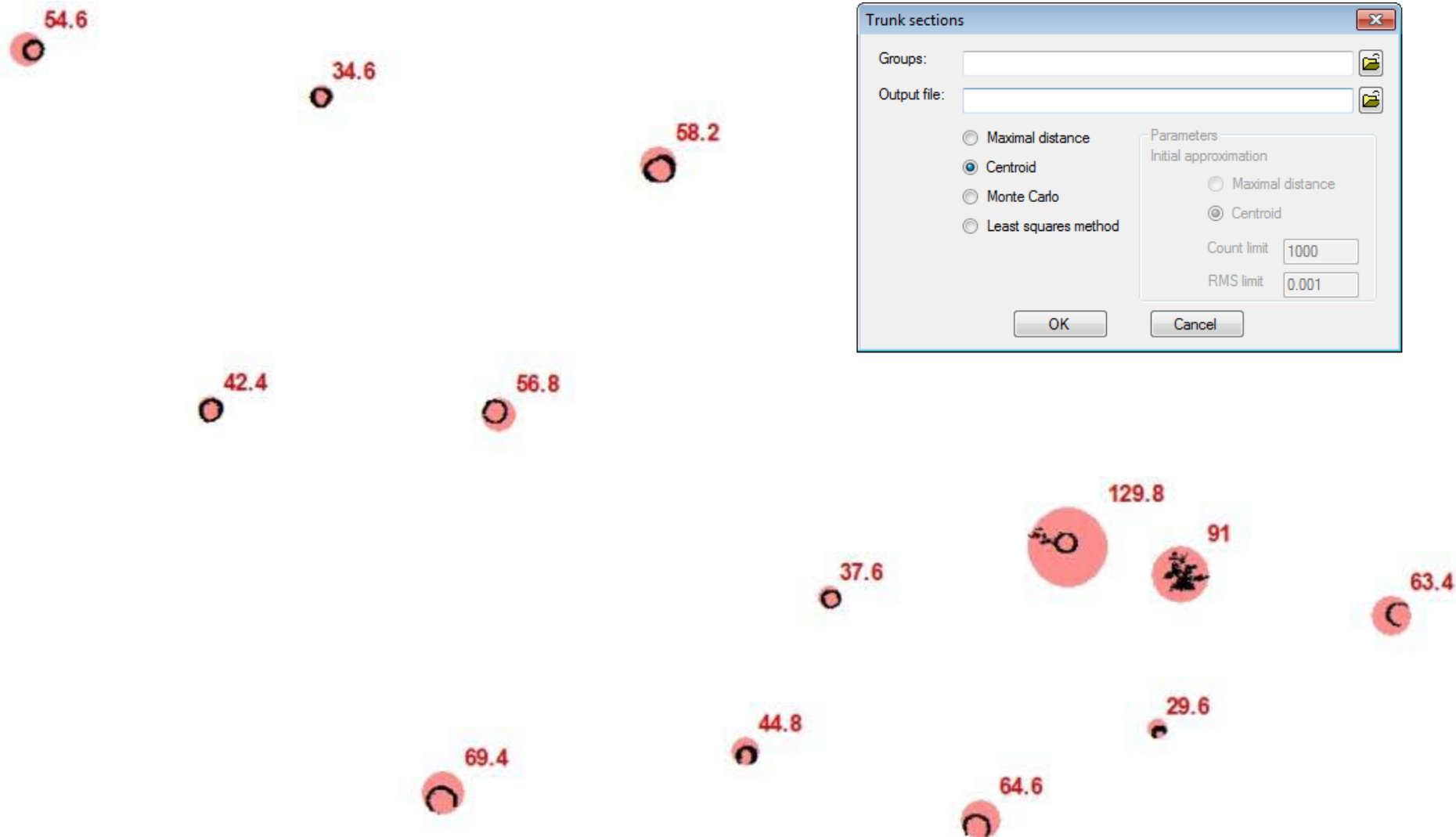
C21

Horizontal cross-sections

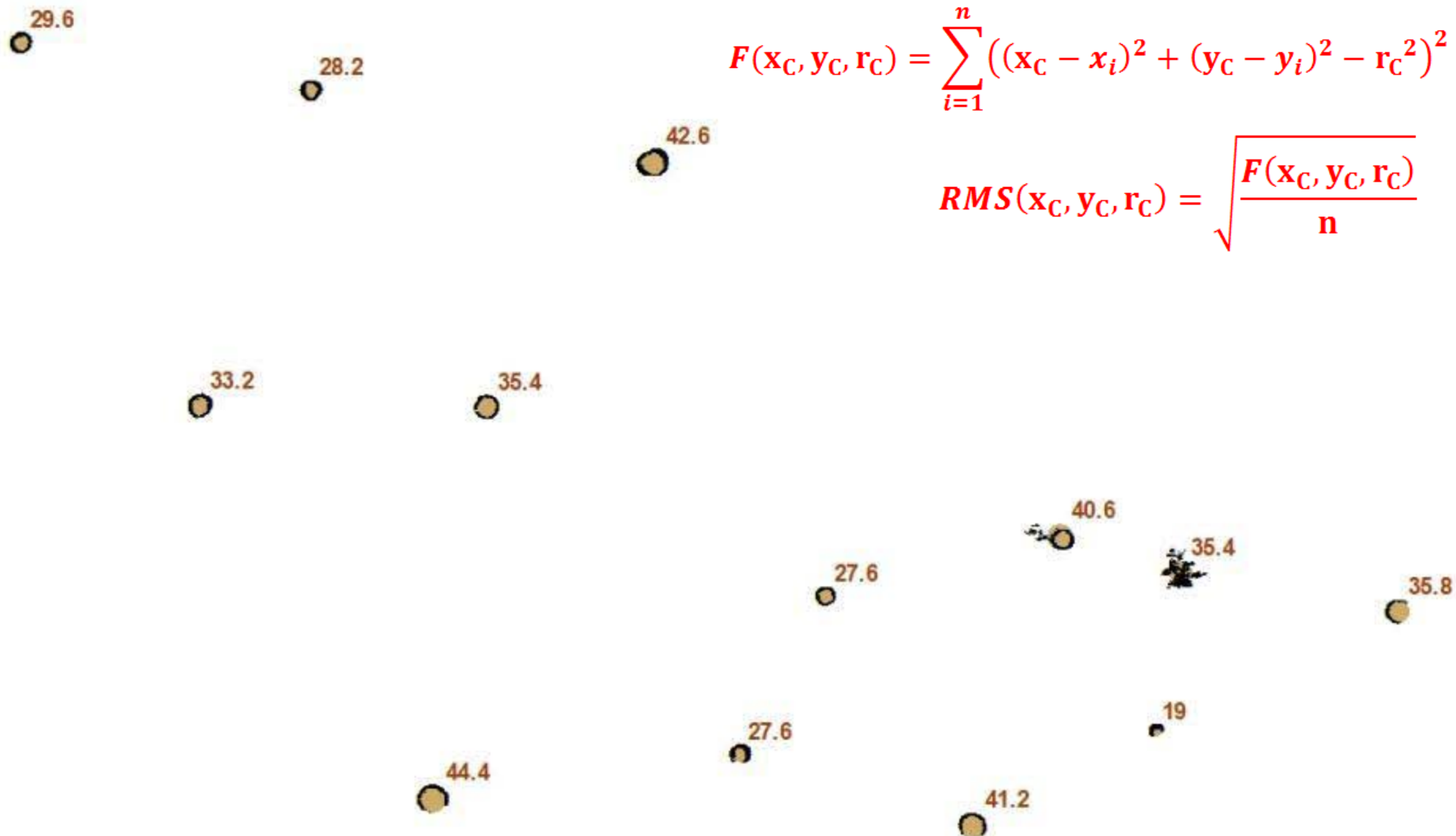
3m



Tree diameter



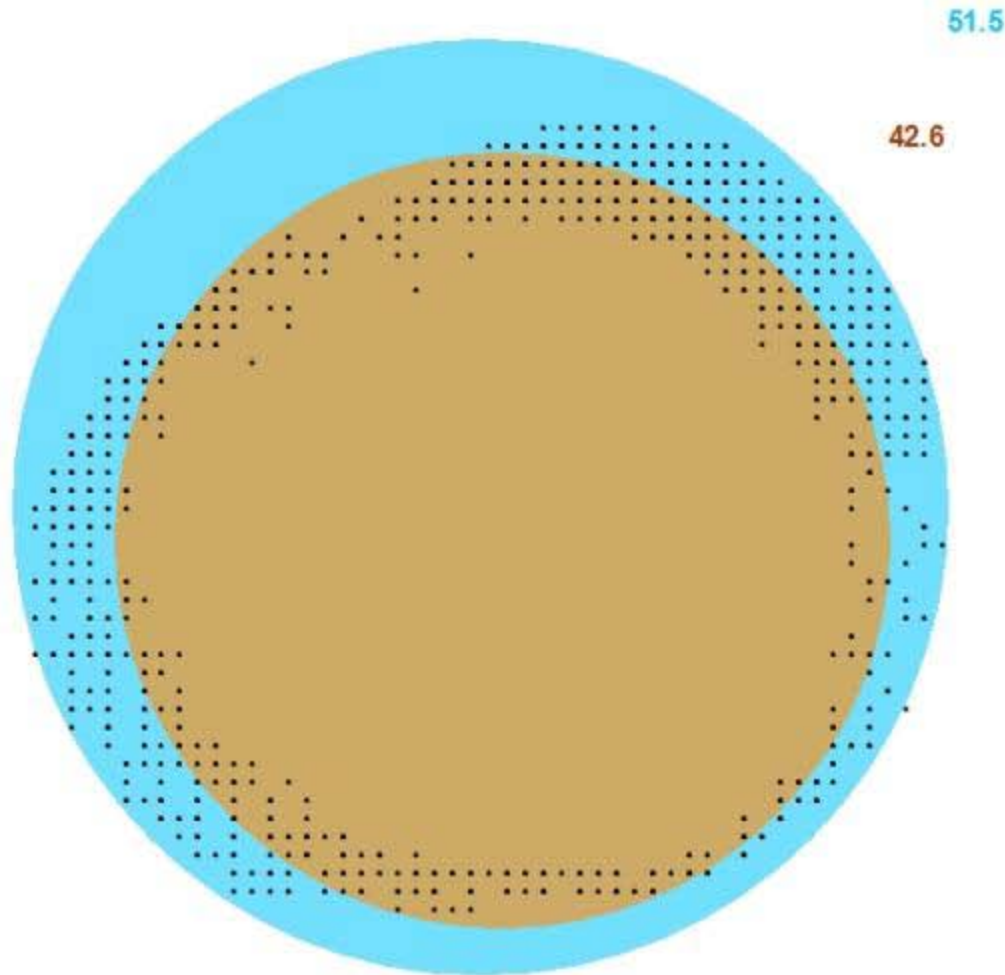
Optimal circle



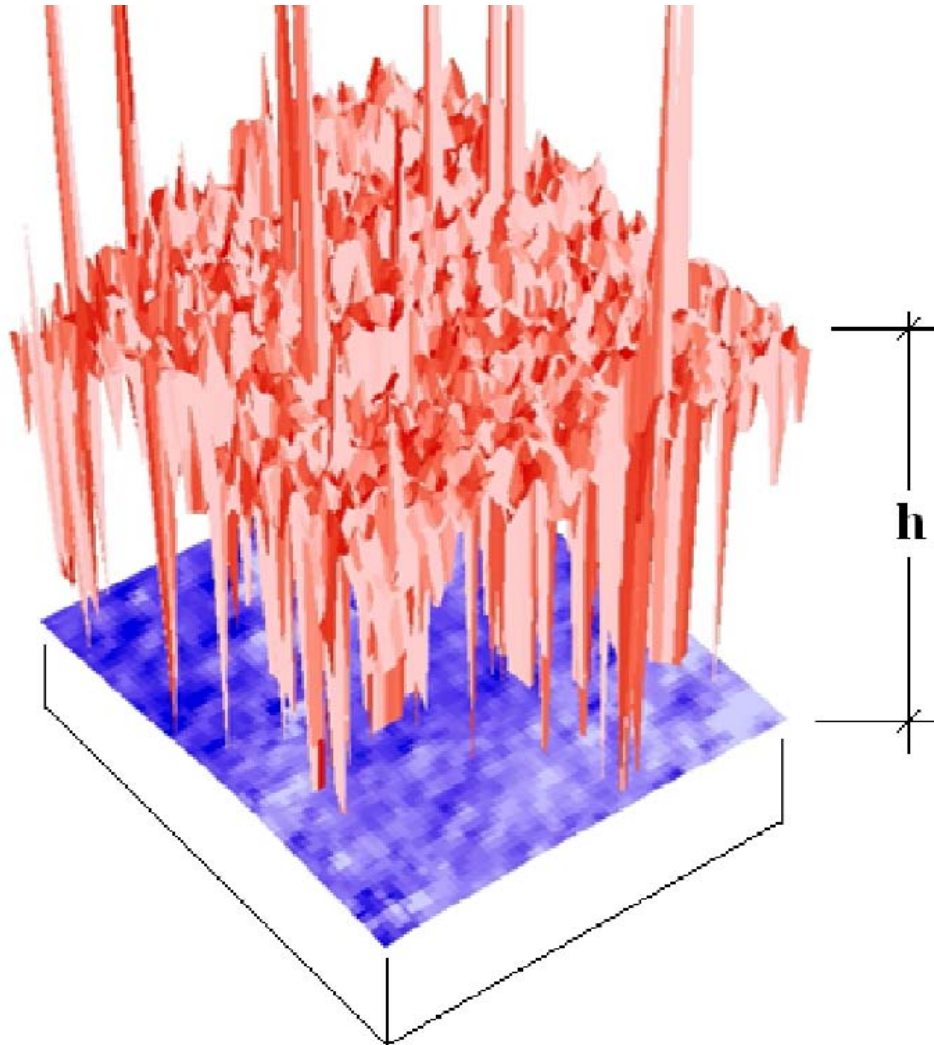
Horizontal cross-section

Optimal circle

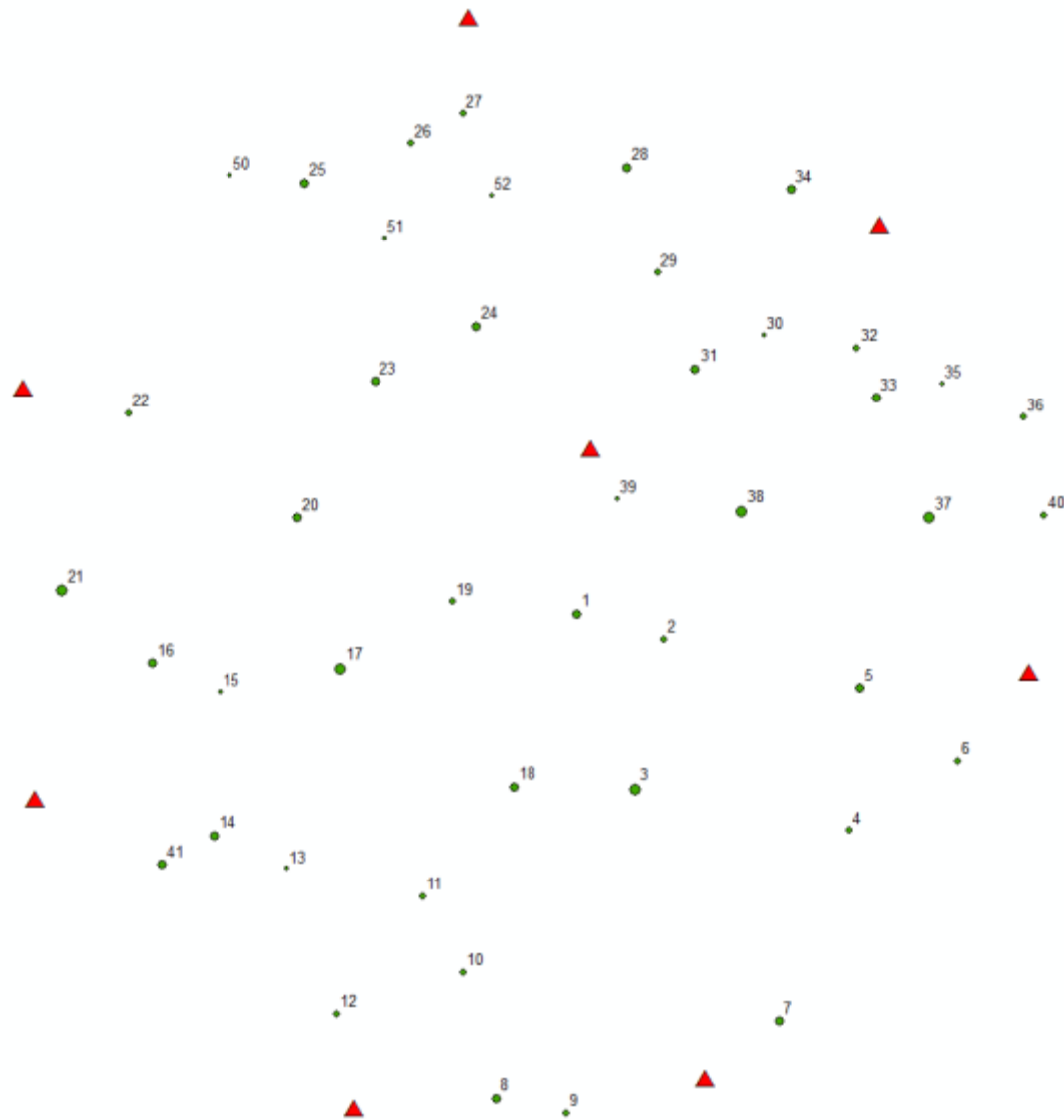
Maximal distance



Tree height



Plot Ba21



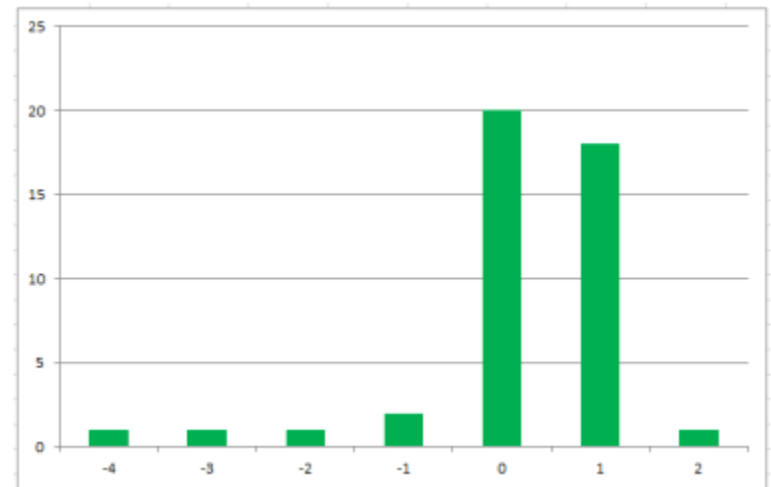
Plot Ba21

<i>id</i>	<i>x</i>	<i>y</i>	<i>z</i>	<i>tls_d</i>	<i>tls_h</i>	<i>point_count</i>	<i>max_dst</i>	<i>rms</i>	<i>field_d</i>	<i>field_h</i>	<i>delta_d</i>	<i>delta_h</i>
1	-0.55	-6.64	23.10	38.0	26.23	8075	0.423	0.007	38.4	26.7	0.44	0.47
2	2.90	-7.63	23.13	27.0	19.91	4704	0.312	0.007	25.8	21.1	-1.20	1.19
3	1.74	-13.66	23.15	43.4	9.23	4380	0.479	0.009	43.0	20.0	-0.45	10.77
4	10.36	-15.32	23.18	28.2	21.18	4306	0.321	0.007	28.5	21.2	0.27	0.02
5	10.80	-9.61	23.21	33.2	22.91	2748	0.353	0.006	34.1	24.4	0.87	1.49
6	14.67	-12.54	23.09	30.3	21.64	7847	0.317	0.008	29.8	23.3	-0.53	1.66
7	7.54	-22.96	23.17	33.9	21.10	4655	0.377	0.005	33.7	23.2	-0.16	2.10
8	-3.80	-26.07	23.09	34.2	24.06	6477	0.383	0.007	35.8	24.9	1.62	0.84
9	-1.00	-26.66	23.09	28.5	22.95	7713	0.315	0.009	28.8	22.6	0.21	-0.35
10	-5.14	-20.99	23.13	28.4	21.32	5592	0.330	0.008	28.0	22.5	-0.45	1.18
11	-6.75	-17.96	23.12	26.3	21.98	2712	0.281	0.003	25.4	22.8	-0.91	0.82
12	-10.20	-22.64	23.00	24.1	20.08	10520	0.271	0.004	23.9	20.2	-0.27	0.12
13	-12.21	-16.83	23.12	15.4	22.16	2486	0.174	0.003	15.1	17.5	-0.29	-4.66
14	-15.09	-15.53	23.10	33.6	22.98	6119	0.370	0.005	33.2	24.8	-0.43	1.82
15	-14.88	-9.76	23.03	19.6	16.87	3147	0.228	0.007	19.8	18.7	0.16	1.83
16	-17.59	-8.61	23.02	31.7	24.95	5978	0.349	0.005	31.4	26.3	-0.35	1.35
17	-10.09	-8.82	23.11	48.4	25.51	6316	0.539	0.011	49.9	26.1	1.47	0.59
18	-3.09	-13.58	23.10	38.6	24.47	5110	0.410	0.005	39.3	24.2	0.63	-0.27
19	-5.54	-6.14	23.03	22.8	20.70	3310	0.249	0.004	22.7	21.7	-0.12	1.00
20	-11.79	-2.75	23.09	31.9	20.38	4567	0.349	0.005	32.5	21.1	0.58	0.72
21	-21.25	-5.71	23.09	43.9	24.54	4299	0.489	0.006	46.9	26.5	2.98	1.96
22	-18.55	1.42	23.03	30.5	21.65	10870	0.338	0.007	30.5	24.0	-0.02	2.35
23	-8.67	2.72	23.03	32.3	22.26	5206	0.356	0.007	32.0	22.5	-0.39	0.24
24	-4.60	4.92	23.03	35.2	22.12	7213	0.393	0.006	36.0	22.5	0.80	0.38
25	-11.52	10.65	23.10	35.0	25.94	4720	0.384	0.007	35.5	27.0	0.49	1.06

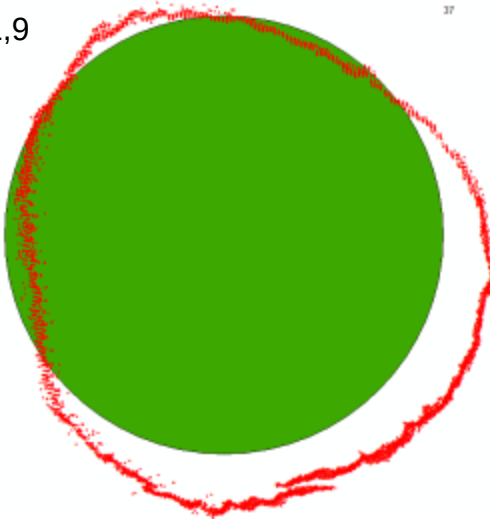
Tree diameter - plot Ba21

Tree diameter

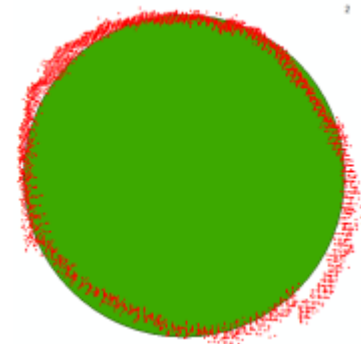
Min -4,14
Max 1,20
Avg -0,29
Std 1,10



Min -4,14
Id = 37
d = 46 / 41,9



Max 1,20
Id = 2
d = 25,8 / 27

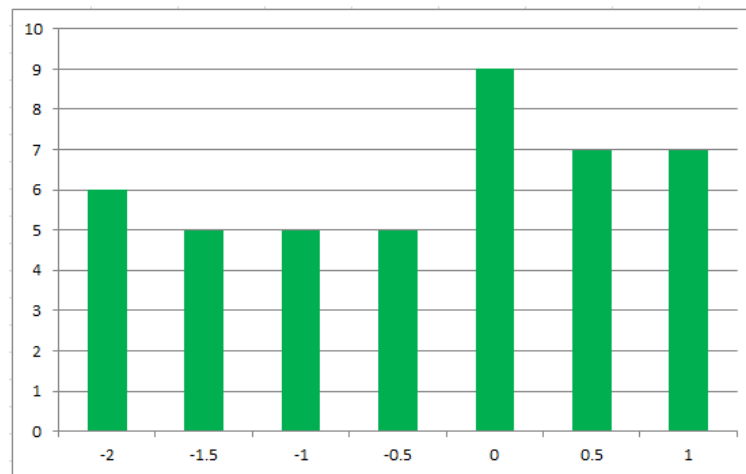


Tree height - plot Ba21

Tree height

Min -10,77
Max 17,74
Avg -0,12
Std 3.68

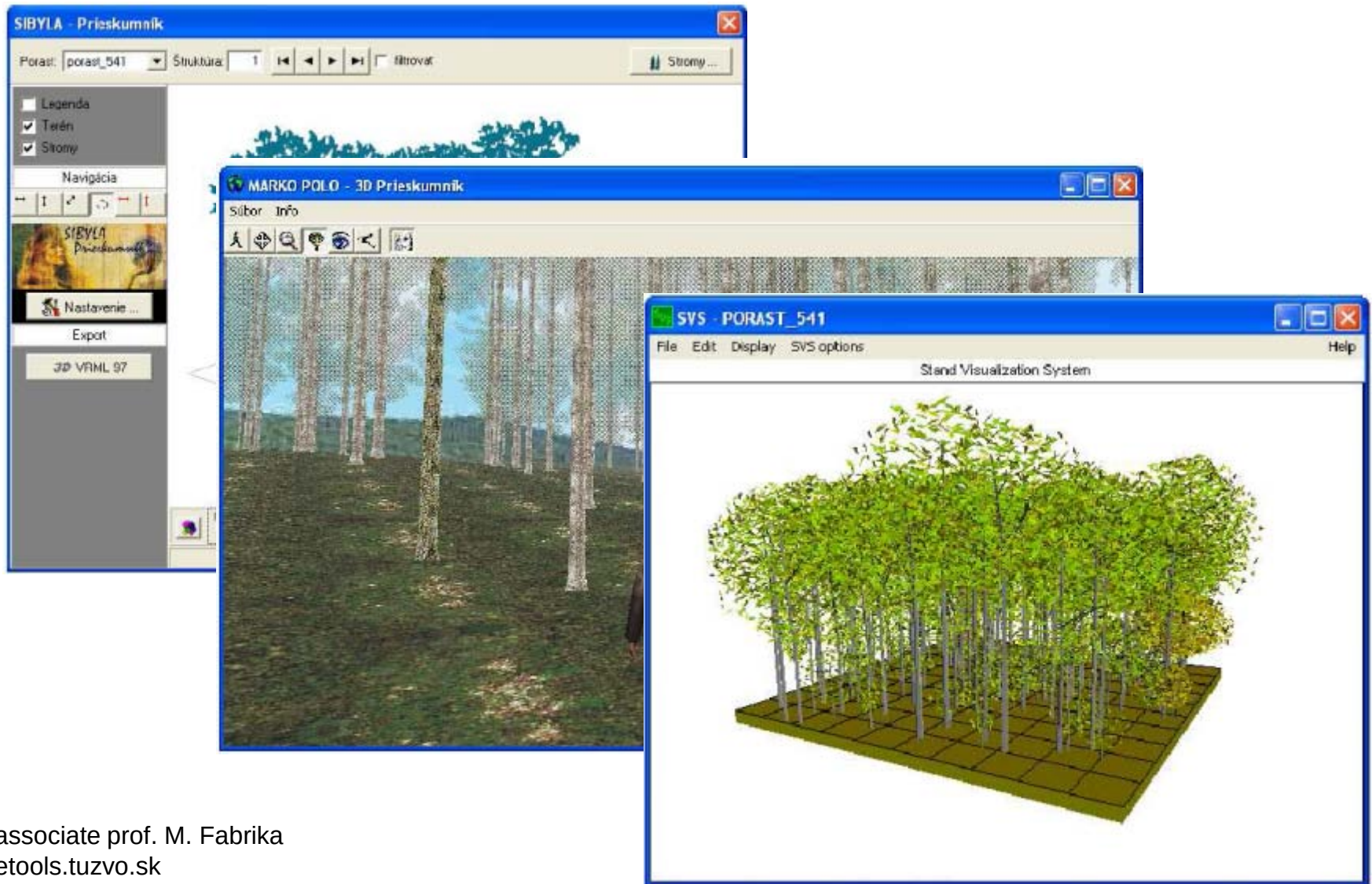
Min -10,77
Id = 3
h = 9,23 / 20,0



Max 17,74
Id = 51 (dead)
h = 21,31 / 3,6



Forest growth simulations and VR

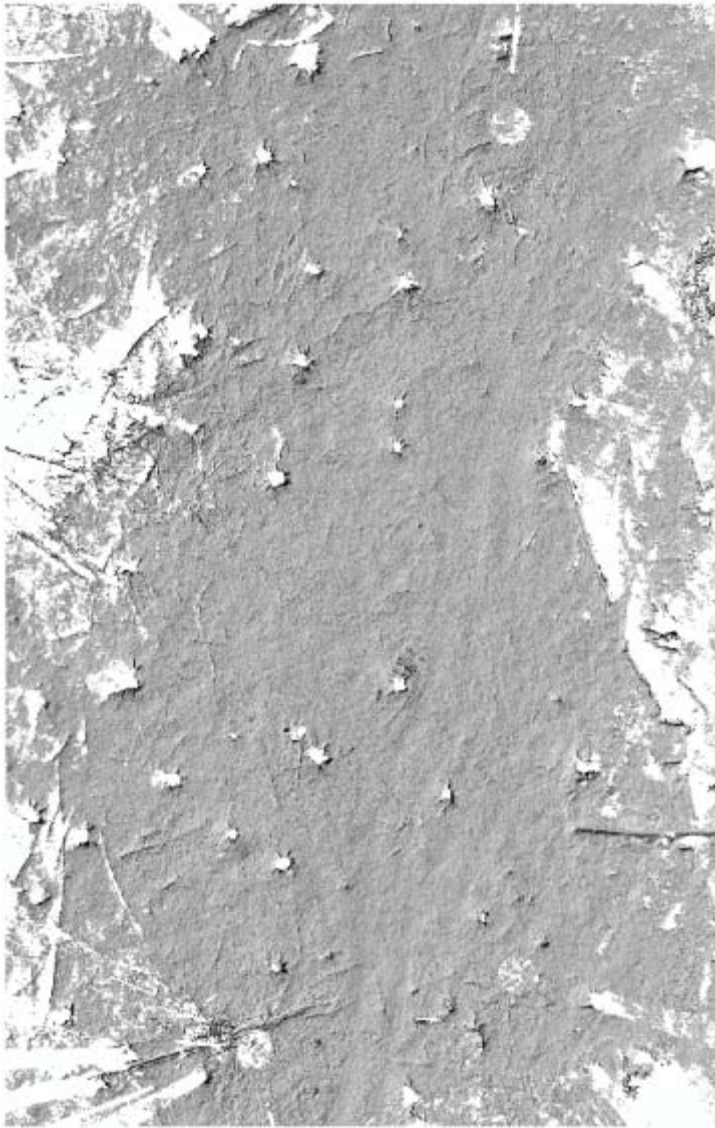


associate prof. M. Fabrika
etools.tuzvo.sk

Damage of skidding trail

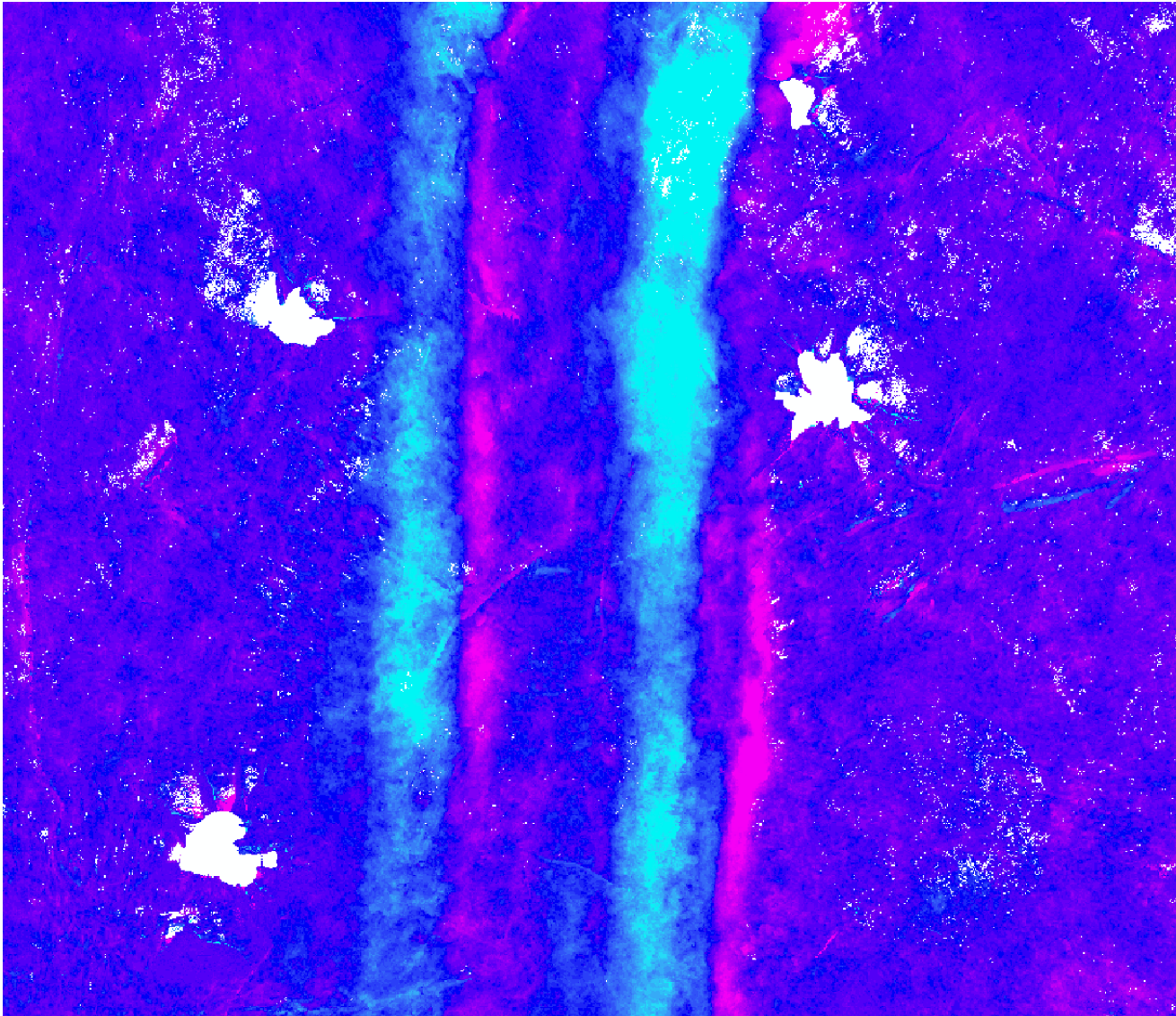


Damage of skidding trail



Damage of skidding trail

DEM
1cm



Damage of trees near the skidding trail

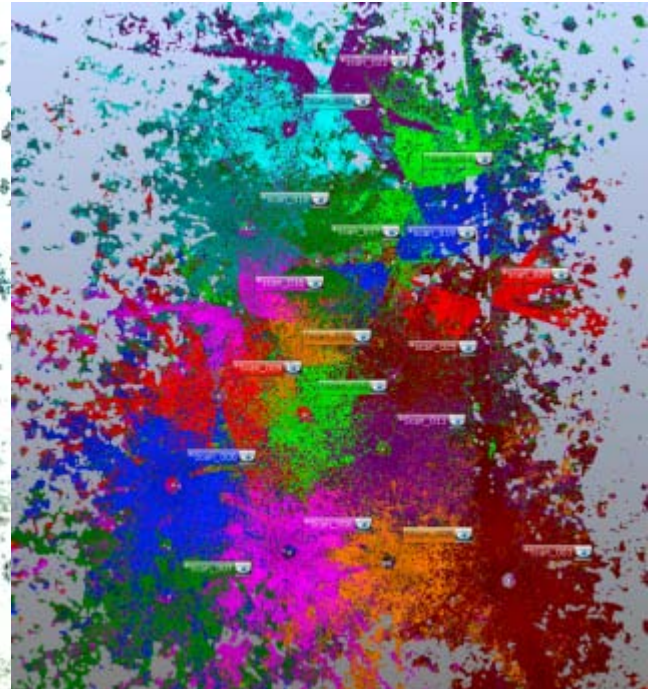
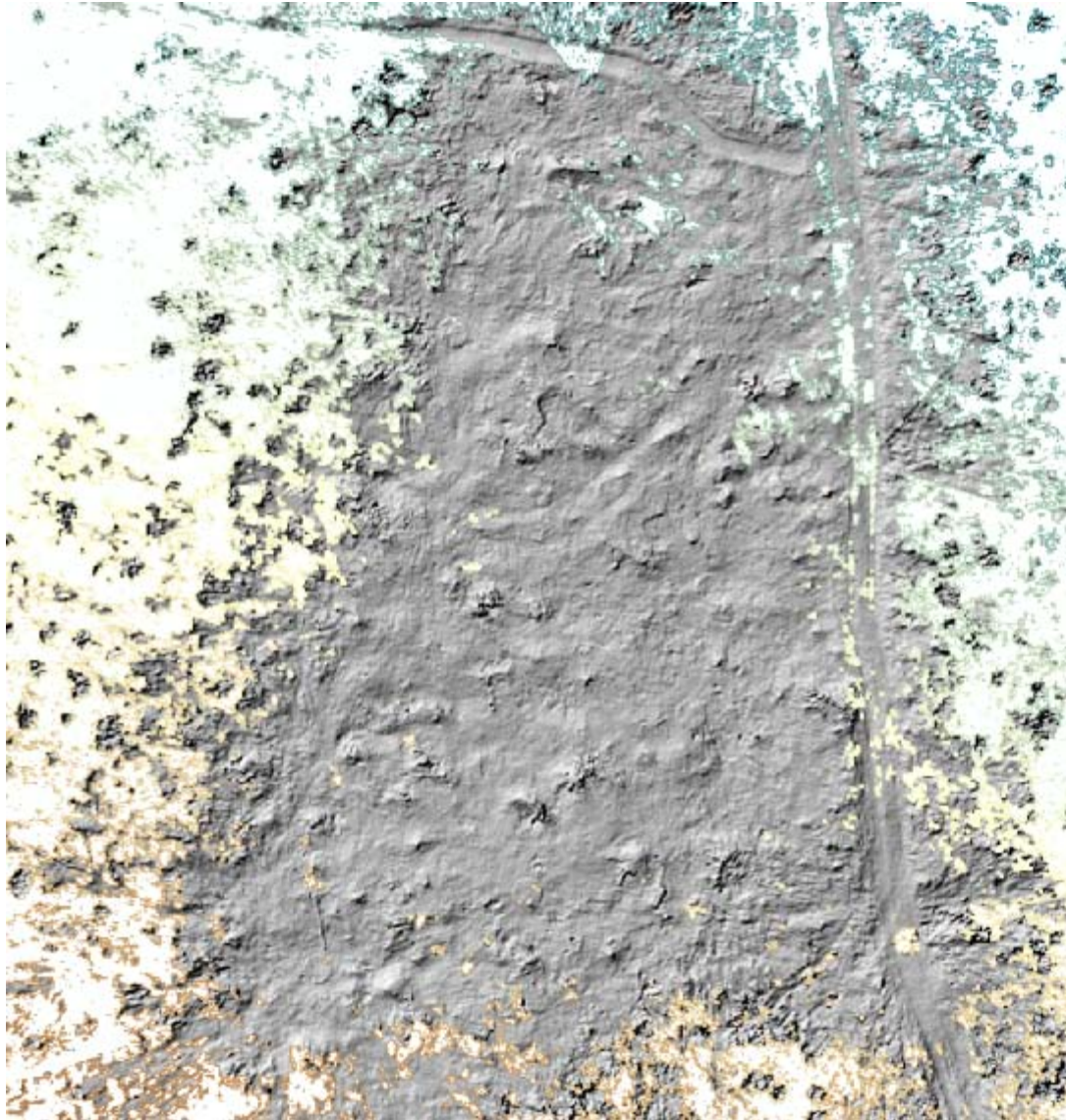


High precision DEM – C production

Research Station of Tatra National Park
Dr. Peter Fleischer
Tatranské Zruby



Carbon production



Phenological observations

Veľká Stráž, Zvolen
5 plots, different forest types
Interval of measurements: 2-10 days

08.04.2013



01.05.2013



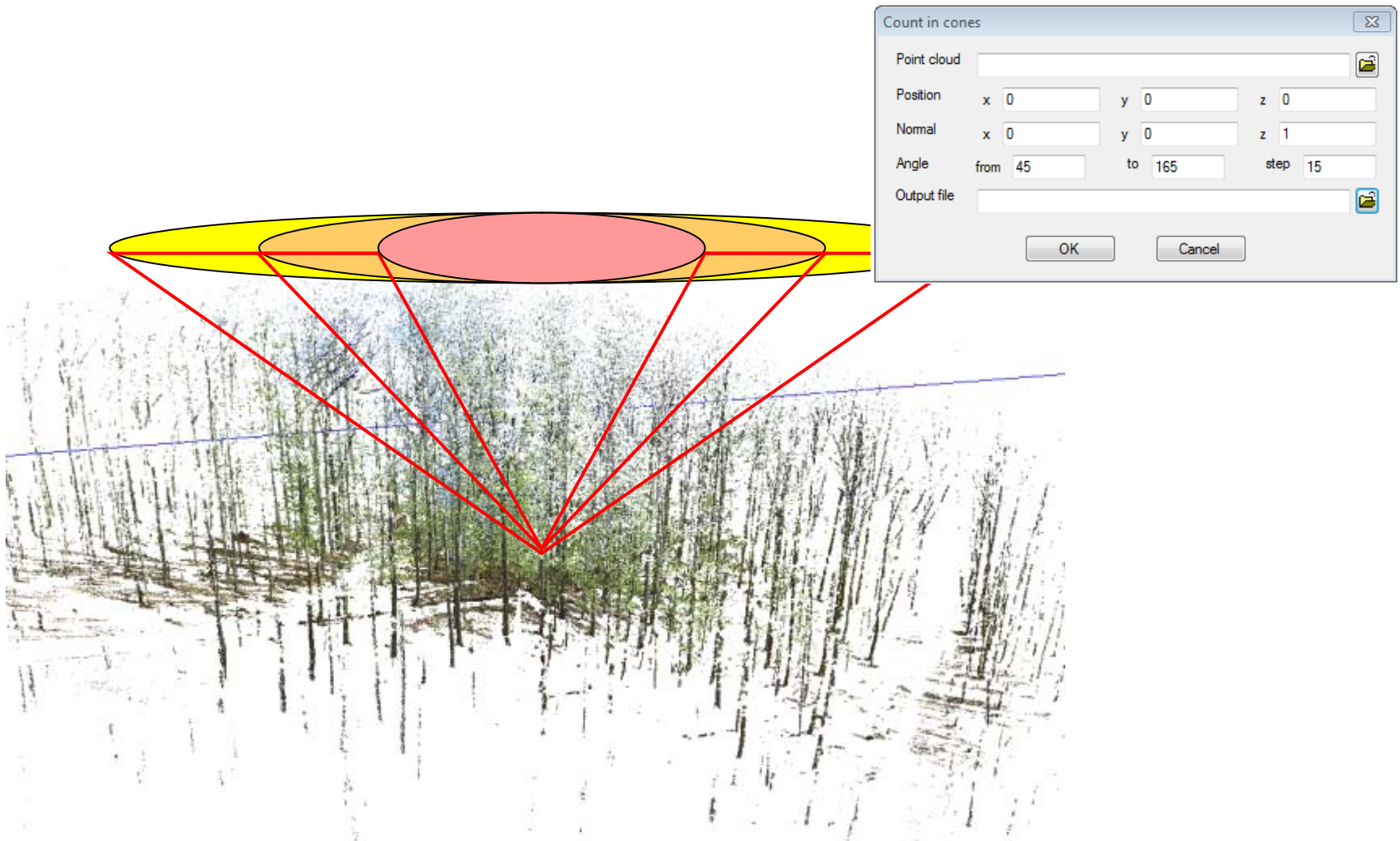
24.04.2014

Nový Smokovec, Slovakia

28

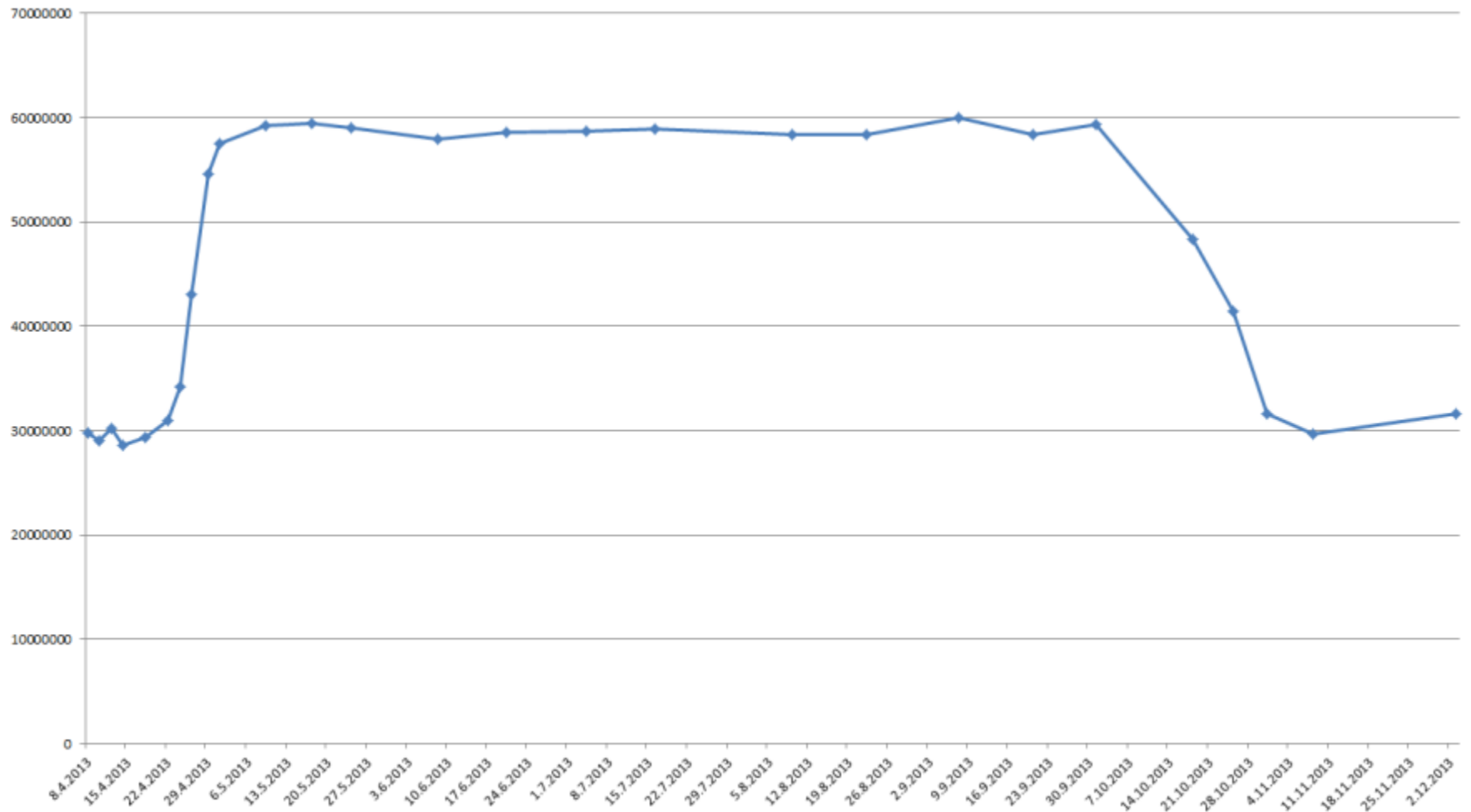
Phenological observations

Number of laser pulse returns in vertical cones of different sizes



Phenological observations

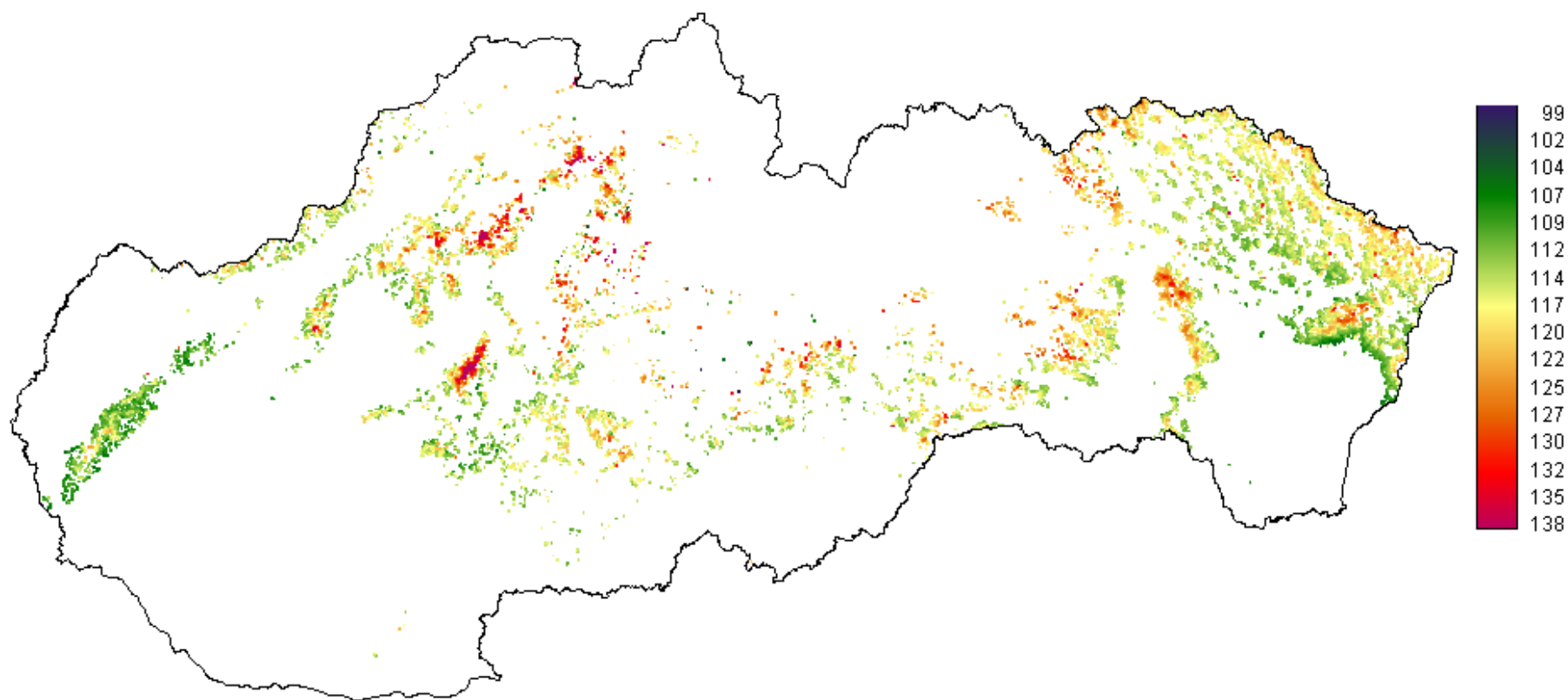
Phenological curve



Phenological observations

BUCHA, T. - PRIWITZER, T. - KOREŇ, M. (2011). Modelovanie fenologického vývoja lesných porastov pomocou vegetačného indexu NDVI odvodeného zo satelitných snímok MODIS. Lesnícky časopis, 3/2011, str. 187-196

$$v(t) = v_{\min} + v_{\text{amp}} \left(\frac{1}{1 + e^{m_1 + m_2 t}} - \frac{1}{1 + e^{m_3 + m_4 t}} \right)$$



WebShare - tls.tuzvo.sk

