Comparison between Two Methods of Non-Destructive Evaluation of Standing Trees

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Background

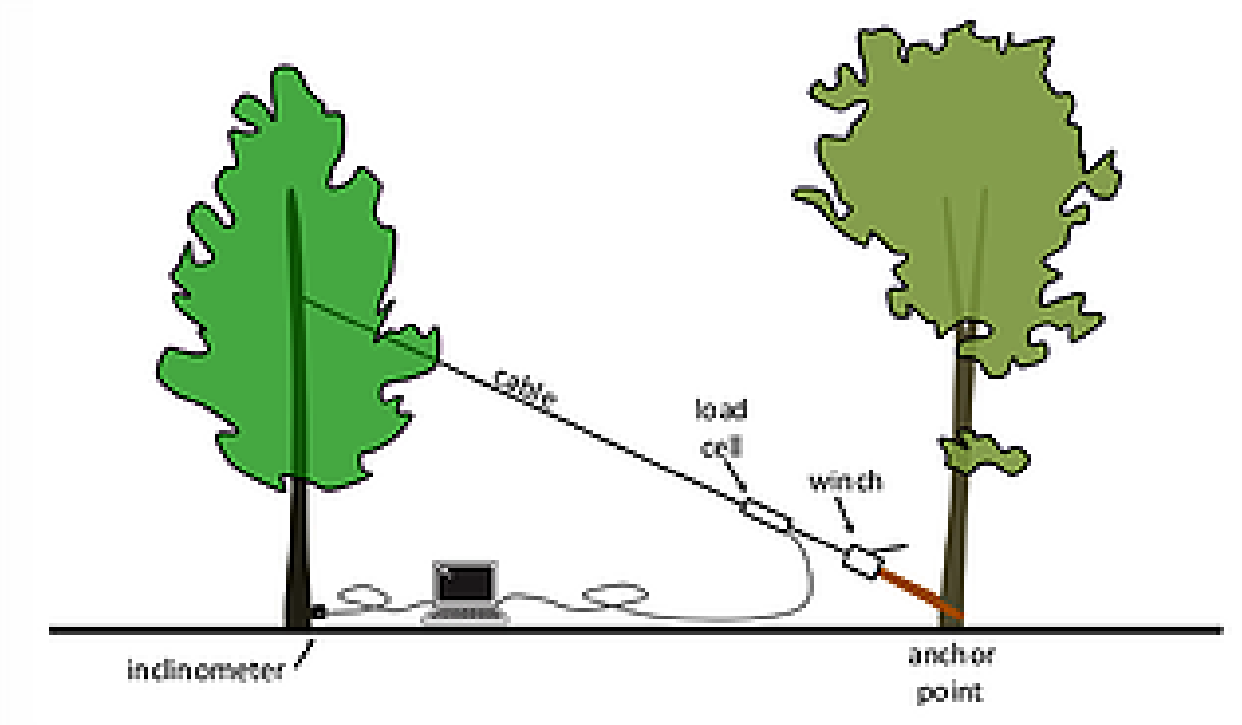
Introduction of DynaRoot system

Introduction of Pulling test

Result

Discussion

How the pulling test work?



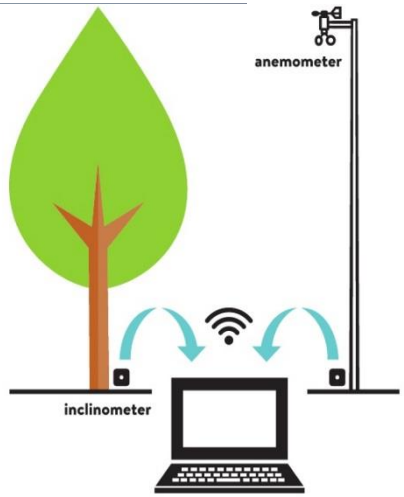
Introduction of DynaRoot System

In this study for measuring the stability root were used DynaRoot system. Dynamic root stability determination using natural wind loads. Allows simultaneous assessment of multiple trees.

DynaRoot System has 3 main part

Anemometer

An instrument for measuring wind velocity at or near the tree to be evaluated. The closer is better, depending on the wind velocity Dynaroot may provide reliable data even with measurements taken several kilometers/miles a way. The anemometer provides wind velocity data. Ideally the anemometer should be clear of buildings or other objects that may objects the wind, at a height at least 10 meter



Dual axis Inclinometer

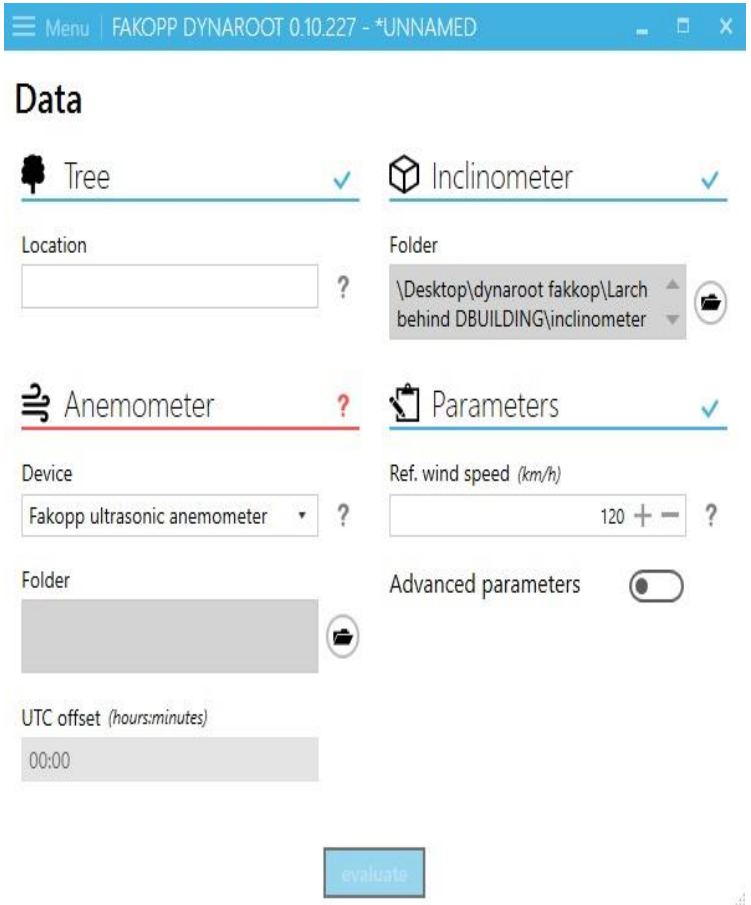
An instrument affixed to the root collar that measures the inclination of trunk in two different direction the instrument provides very accurate inclination data, the sampling rate is 10 Hz. with sufficient frequency and measurement range ±2 degree, resolution:0.001 degree.

Evaluation Software

The data was transferred into the DynaRoot Evaluation software, which estimated the critical wind pressure (P_{wind}), based on the statistical parameters of the data sets. Safety factor (SF) is calculated for a given wind velocity value of the area. In Hungary V_{wind} = 33m/s and ρ_{air}=1.2kg/m3.

$$P_{wind} = \frac{\rho_{air}}{2} V^2$$

$$\mathrm{SF} = \frac{P_{crit}}{P_{wind}}$$



Critical wind pressure

Safety factor

Correlation coefficient

Wind direction

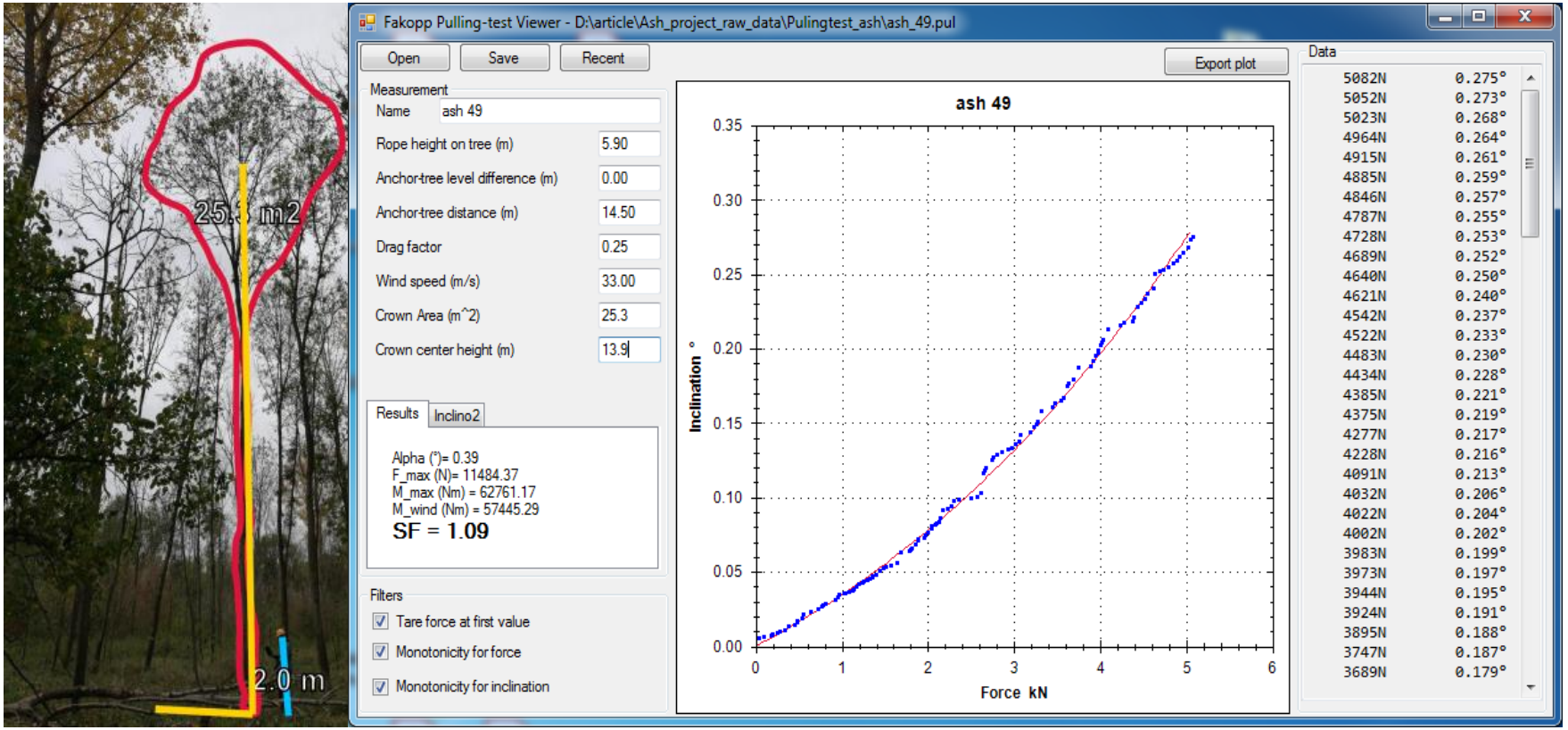
Linear relationship

Relation tangent

Compare between pulling test and DynaRoot SYSTEM

Pulling test is the static method for measuring stability of tree roots. In this method, the main force is mechanical, and it can damage the tree. However, in DynaRoot system the static loading is replaced by actual wind loads. e .Dynamic methods are faster and simpler to carry out than the Pulling test, use a more realistic loading scenario, and there is no chance of damaging the tree

Result


25.3 m2
2.0 m
Fakopp Pulling-test Viewer - D:\article\Ash_project_raw_data\Pulingtest_ash\ash_49.pul
Open
Save
Recent
Export plot
Measurement
Name ash 49
Rope height on tree (m) 5.90
Anchor-tree level difference (m) 0.00
Anchor-tree distance (m) 14.50
Drag factor 0.25
Wind speed (m/s) 33.00
Crown Area (m^2) 25.3
Crown center height (m) 13.9
Results
Inclino2
Alpha (°)= 0.39
F_max (N)= 11484.37
M_max (Nm) = 62761.17
M_wind (Nm) = 57445.29
SF = 1.09
Filters
Tare force at first value
Monotonicity for force
Monotonicity for inclination
ash 49
Inclination °
Force kN
Data
5082N 0.275°
5052N 0.273°
5023N 0.268°
4964N 0.264°
4915N 0.261°
4885N 0.259°
4846N 0.257°
4787N 0.255°
4728N 0.253°
4689N 0.252°
4640N 0.250°
4621N 0.240°
4542N 0.237°
4522N 0.233°
4483N 0.230°
4434N 0.228°
4385N 0.221°
4375N 0.219°
4277N 0.217°
4228N 0.216°
4091N 0.213°
4032N 0.206°
4022N 0.204°
4002N 0.202°
3983N 0.199°
3973N 0.197°
3944N 0.195°
3924N 0.191°
3895N 0.188°
3747N 0.187°
3689N 0.179°

Fakopp Pulling-test Viewer - D:\article\Ash_project_raw_data\Pulingtest_ash\ash_54.pul

Open | Save | Recent | Export plot

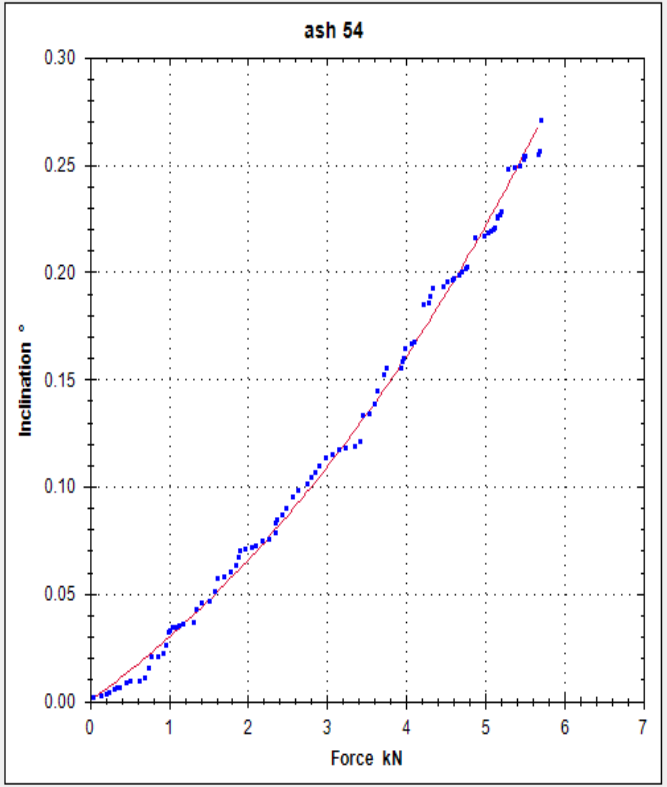
Measurement

Name	ash 54
Rope height on tree (m)	5.50
Anchor-tree level difference (m)	0.00
Anchor-tree distance (m)	10.40
Drag factor	0.25
Wind speed (m/s)	33.00
Crown Area (m^2)	27.2
Crown center height (m)	14.1

Results | Inclino2

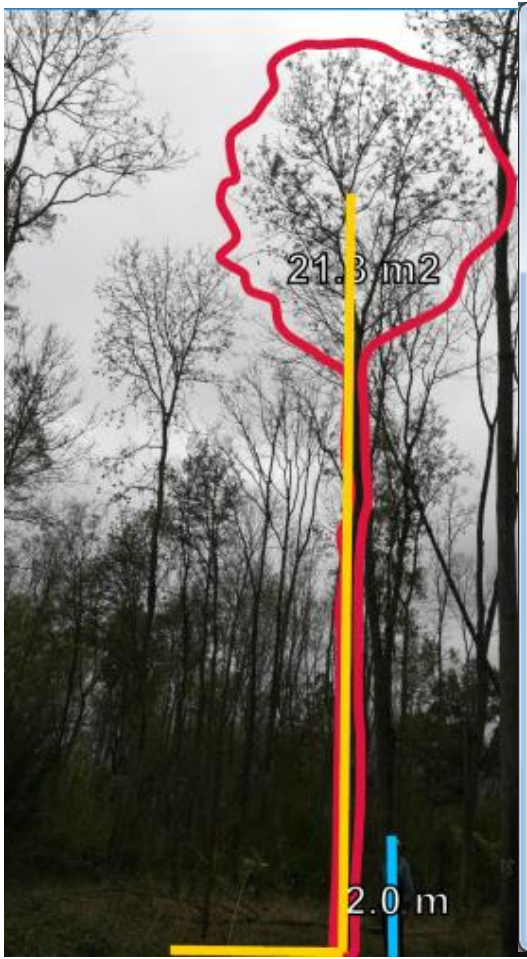
Alpha (°)= 0.49
F_max (N)= 13245.85
M_max (Nm) = 64400.95
M_wind (Nm) = 62647.99
SF = 1.03

Filters
- [x] Tare force at first value
- [x] Monotonicity for force
- [x] Monotonicity for inclination



Data

5709N	0.271°
5690N	0.256°
5680N	0.255°
5513N	0.254°
5494N	0.254°
5484N	0.252°
5445N	0.249°
5366N	0.249°
5288N	0.248°
5199N	0.228°
5189N	0.227°
5160N	0.226°
5150N	0.225°
5121N	0.221°
5111N	0.220°
5072N	0.219°
5042N	0.218°
4983N	0.217°
4866N	0.216°
4768N	0.202°
4758N	0.201°
4709N	0.200°
4679N	0.198°
4611N	0.197°
4581N	0.196°
4522N	0.195°
4473N	0.193°
4346N	0.192°
4307N	0.189°
4287N	0.186°
4228N	0.184°



Fakopp Pulling-test Viewer - D:\article\Ash_project_raw_data\Pulingtest_ash\ash_56.pul

Open | Save | Recent | Export plot

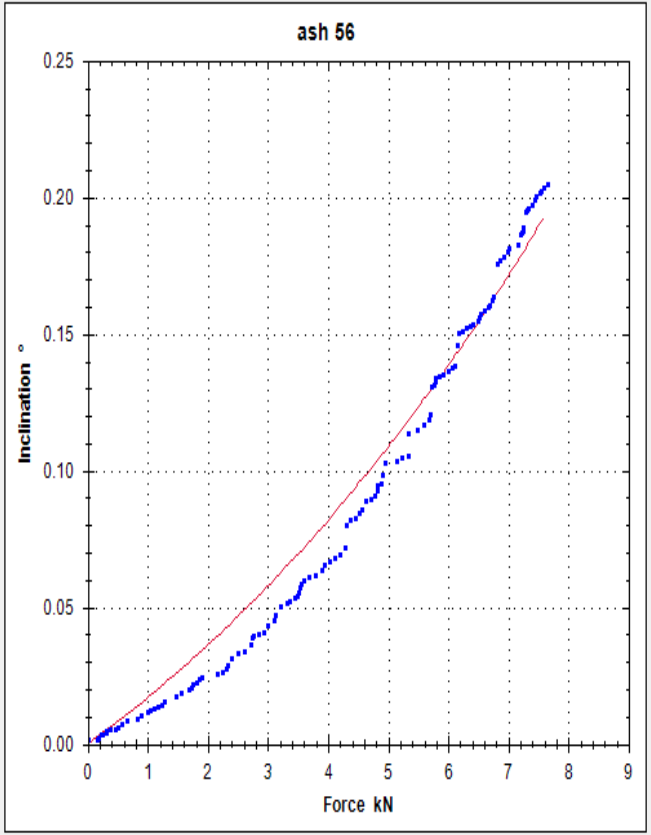
Measurement

Name	ash 56
Rope height on tree (m)	5.50
Anchor-tree level difference (m)	0.00
Anchor-tree distance (m)	18.80
Drag factor	0.25
Wind speed (m/s)	33.00
Crown Area (m^2)	21.3
Crown center height (m)	11

Results | Inclino2

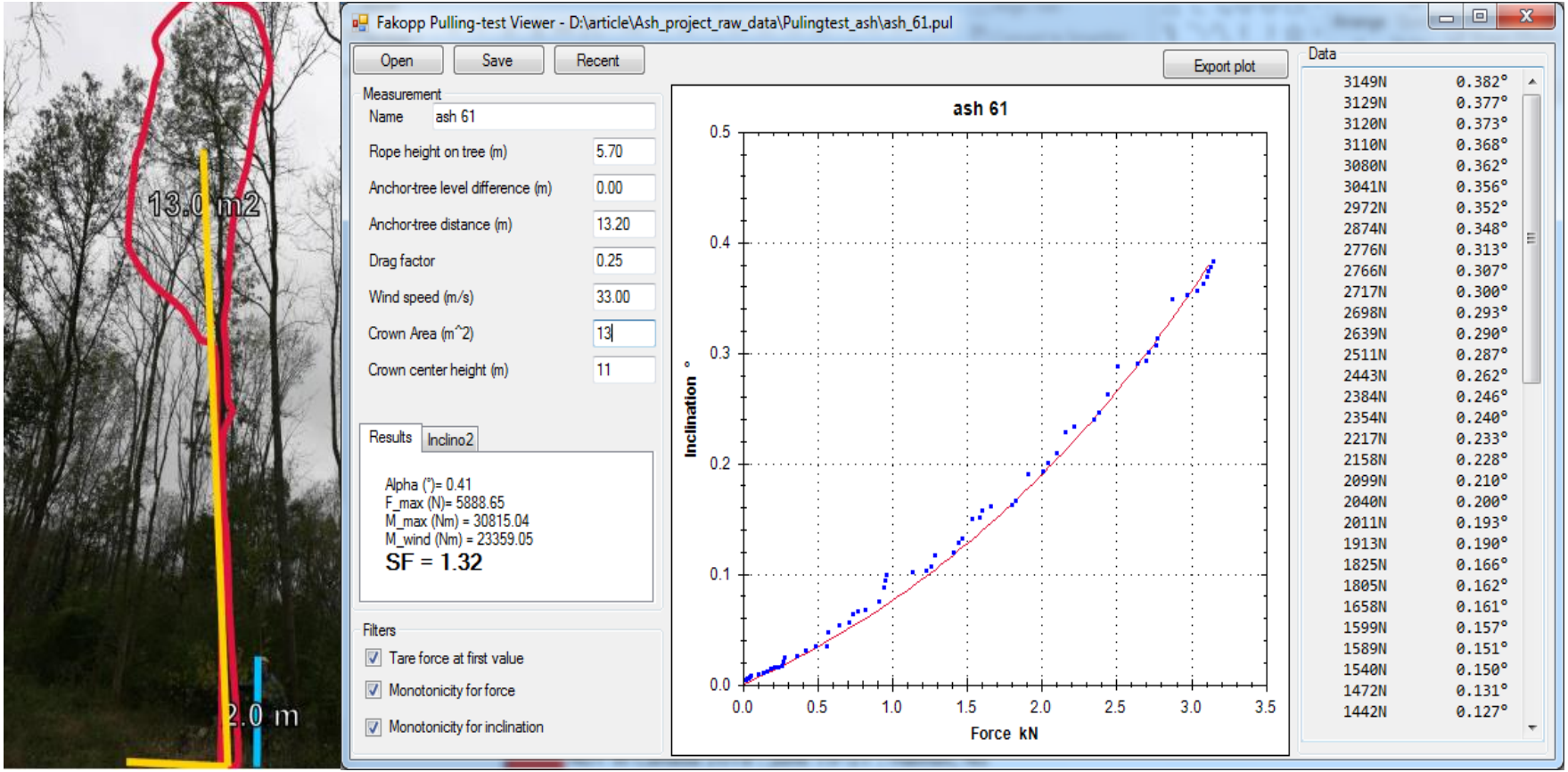
Alpha (°)= 0.28
F_max (N)= 22113.70
M_max (Nm) = 116732.49
M_wind (Nm) = 38272.91
SF = 3.05

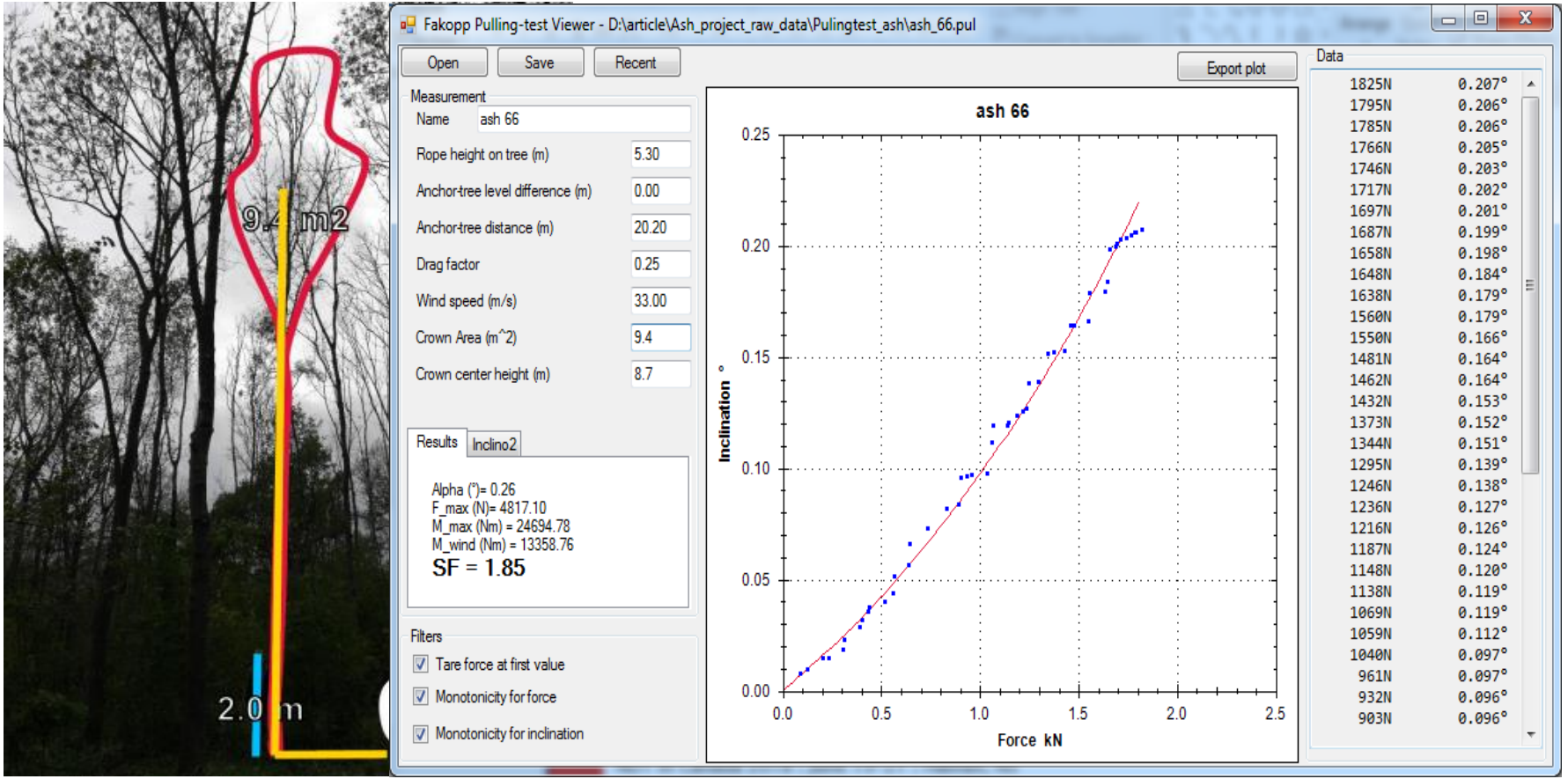
Filters
- [x] Tare force at first value
- [x] Monotonicity for force
- [x] Monotonicity for inclination



Data

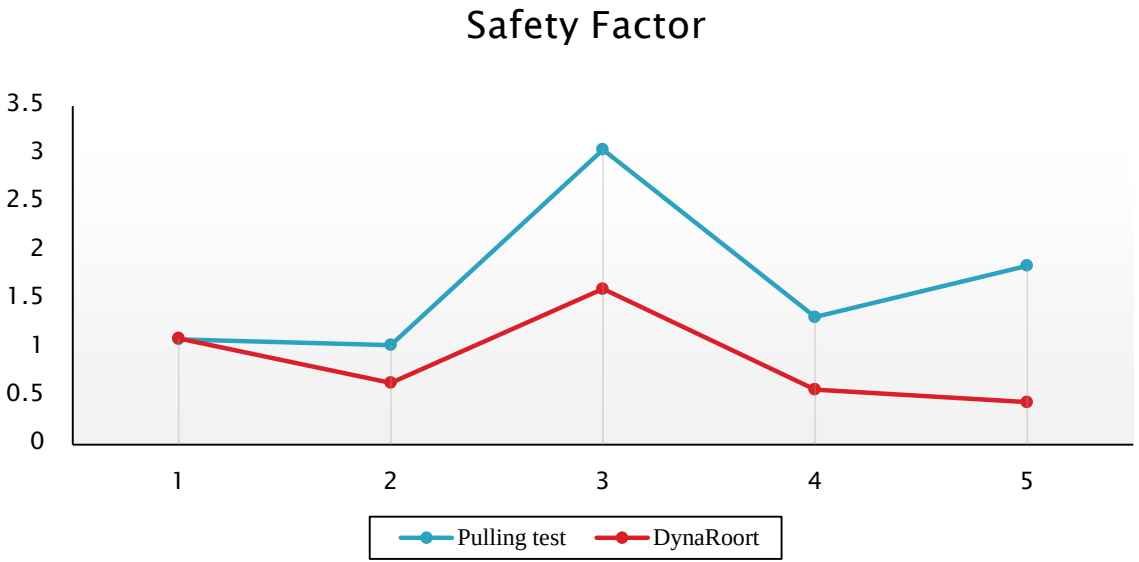
7652N	0.204°
7603N	0.204°
7564N	0.202°
7534N	0.202°
7475N	0.200°
7446N	0.199°
7397N	0.197°
7338N	0.196°
7308N	0.195°
7289N	0.194°
7259N	0.189°
7250N	0.187°
7230N	0.187°
7210N	0.186°
7171N	0.182°
7024N	0.181°
6995N	0.180°
6926N	0.178°
6877N	0.177°
6818N	0.175°
6759N	0.163°
6730N	0.162°
6700N	0.161°
6671N	0.160°
6612N	0.158°
6553N	0.157°
6524N	0.156°
6494N	0.155°
6426N	0.153°
6377N	0.153°
6308N	0.152°


13.0 m2
2.0 m
Fakopp Pulling-test Viewer - D:\article\Ash_project_raw_data\Pulingtest_ash\ash_61.pul
Open
Save
Recent
Export plot
Measurement
Name
ash 61
Rope height on tree (m)
5.70
Anchor-tree level difference (m)
0.00
Anchor-tree distance (m)
13.20
Drag factor
0.25
Wind speed (m/s)
33.00
Crown Area (m^2)
13
Crown center height (m)
11
Results
Inclino2
Alpha (°)= 0.41
F_max (N)= 5888.65
M_max (Nm) = 30815.04
M_wind (Nm) = 23359.05
SF = 1.32
Filters
Tare force at first value
Monotonicity for force
Monotonicity for inclination
ash 61
Inclination °
Force kN
0.0
0.1
0.2
0.3
0.4
0.5
0.5
1.0
1.5
2.0
2.5
3.0
3.5
Data
3149N 0.382°
3129N 0.377°
3120N 0.373°
3110N 0.368°
3080N 0.362°
3041N 0.356°
2972N 0.352°
2874N 0.348°
2776N 0.313°
2766N 0.307°
2717N 0.300°
2698N 0.293°
2639N 0.290°
2511N 0.287°
2443N 0.262°
2384N 0.246°
2354N 0.240°
2217N 0.233°
2158N 0.228°
2099N 0.210°
2040N 0.200°
2011N 0.193°
1913N 0.190°
1825N 0.166°
1805N 0.162°
1658N 0.161°
1599N 0.157°
1589N 0.151°
1540N 0.150°
1472N 0.131°
1442N 0.127°


9.4 m2
2.0 m
Fakopp Pulling-test Viewer - D:\article\Ash_project_raw_data\Pulingtest_ash\ash_66.pul
Open
Save
Recent
Export plot
Measurement
Name
ash 66
Rope height on tree (m)
5.30
Anchor-tree level difference (m)
0.00
Anchor-tree distance (m)
20.20
Drag factor
0.25
Wind speed (m/s)
33.00
Crown Area (m^2)
9.4
Crown center height (m)
8.7
Results
Inclino2
Alpha (°)= 0.26
F_max (N)= 4817.10
M_max (Nm) = 24694.78
M_wind (Nm) = 13358.76
SF = 1.85
Filters
Tare force at first value
Monotonicity for force
Monotonicity for inclination
ash 66
Inclination °
Force kN
0.00
0.05
0.10
0.15
0.20
0.25
0.0
0.5
1.0
1.5
2.0
2.5
Data
1825N 0.207°
1795N 0.206°
1785N 0.206°
1766N 0.205°
1746N 0.203°
1717N 0.202°
1697N 0.201°
1687N 0.199°
1658N 0.198°
1648N 0.184°
1638N 0.179°
1560N 0.179°
1550N 0.166°
1481N 0.164°
1462N 0.164°
1432N 0.153°
1373N 0.152°
1344N 0.151°
1295N 0.139°
1246N 0.138°
1236N 0.127°
1216N 0.126°
1187N 0.124°
1148N 0.120°
1138N 0.119°
1069N 0.119°
1059N 0.112°
1040N 0.097°
961N 0.097°
932N 0.096°
903N 0.096°

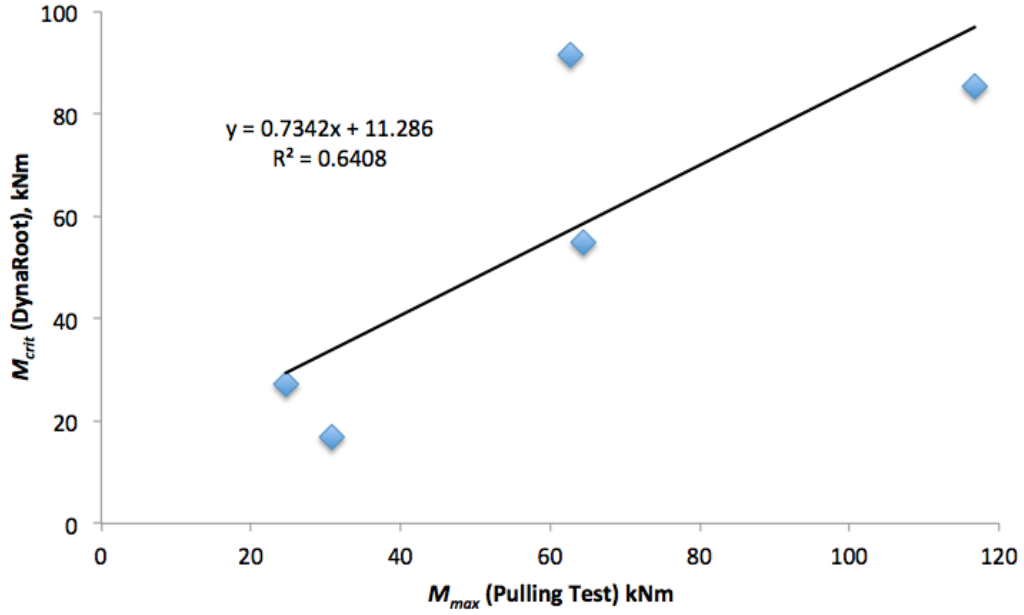
Tree Nr.		1	2	3	4	5
ArborSonic	A (m^2)	25.3	27.2	21.3	13	9.4
	cch (m)	13.9	14.1	11	11	8.7
Pulling test	F_{max} (N)	11484	13245	22113	5889	4817
	M_{max} (Nm)	62761	64401	116732	30815	24695
DynaRoot	P_{crit} (Pa)	1043 ±313	572 ±144	1460 ±383	476 ±94	1329 ±1038
	F_{crit} (N)	6596	3889	7774	1547	3123
	M_{crit} (Nm)	91697	54843	85519	17017	27171

A – crown surface area, cch – crown centerpoint height F_{max}, M_{max} = Predicted uprooting force and torque, pulling test; P_{crit}, F_{crit}, M_{crit} = Predicted uprooting pressure, force and torque, DynaRoot



compare the SF obtained from Pulling test and DynaRoot system

The compare between the Torque of Dynaroot system and Torque of pulling test



Conclusions

5 severely decayed Ash (*Fraxinus Excelsior*) trees were evaluated for stability using the traditional pulling test and an innovative dynamic tree stability evaluation method. The comparision of the two methods yielded the following conclusions:

- The two methods yielded different, but comparable Safety Factor (SF) values at the same reference wind velocity level. Differences were due to differences in measurement direction, the effect of possible shielding on dynamic measurements, and differences inhetent in the two methods.
- The dynamic method provides more conservative SF values.
- Uprooting torque estimates correlate reasonably well between the two methods (R^2 = 0.64) The dynamic method, again, typically, but not consistenty, provided more conservative estimates.

FAKOPP

Thank you for your time and your attention

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