STUDENT RESEARCH COLLOQUIUM

Graphical characterization for the estimation of ten years changes within a Beech (*Fagus sylvativa*) stand (Kahlenberg 86b) in the North East of Germany.

By

Charles Noel Konga Mopoum (FIT)

OUTLINE

➢ Introduction

➢ Material and methods

➢ Analysis and results
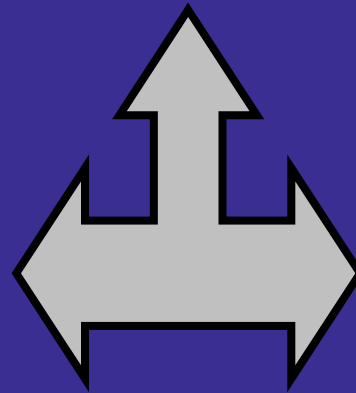
➢ Discussion and conclusion

INTRODUCTION (1/2)

Beech (Fagus Sylvatica)

Description

Tall and slow growth rate deciduous tree specie with broad pyramidal shape

Aspect and livespan

- Can reach 40m height, 3m trunk diameter
- Typical lifespan: 150 to 200 years, sometimes up to 300.

Crowns, productivity, growth and development

In the sylvicultural point of view, crown characteristics of Beech species correlating with its diameter and volume increments have a fundamental importance during the selection of crop trees, securing high quality and stability of stands (Podlaski, 2002).

5/21/2012

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INTRODUCTION (2/2)

- ## General objective:

  Determine the type of relationship that does exist between crown characteristics of a Beech stand and ten years radial increment at the breast height.

- ## Research questions:

  - ➢ How does the location of neighbouring trees affect crown development?
  - ➢ Which crown parameters can be used to explain tree development?

MATERIAL AND METHODS (1/6)

- Data sources:
  - ➤ von Thünen Institute (10 years ago in a 71 years old Beech stand)
  - ➤ Supplemented with data collected during the winter period 2011

- Element of the graphical characterization
  - ➤ Breast height diameters, tree heights, tree location, crown base and crown radii.

Plot location and Characterization
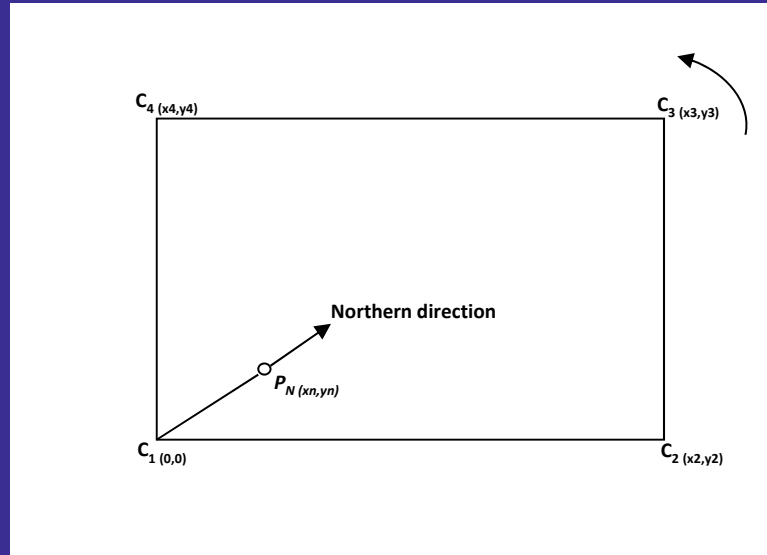
Forest district Kahlenberg
Abt. 86b (52°52'37''N; 13°54'12''O)
4068.70 m^2 (about 80 m x 50 m).

Additionally, the exact location of each single tree (x and y coordinates in the Cartesian system) was also determined

Tree parameters measurements

-BHD : Diameter tape calibrated with a constant pi factor

- Tree height and crown base height: Vertex IV device and its transponder T3

Parameters of the crown form

Lack of direct measurement methods for crown parameters has lead to the fact that crowns are always estimated from below or from above

➢ Crown radii were estimated from below, following vertical projection of crown edges at the ground level, with the help of a mirror mounted on a gimbal and containing signs that ensure a vertical reflection.

➢ Radii were measured in N (4≤N≤8) different directions following neighbouring-trees and eight main cardinal directions.
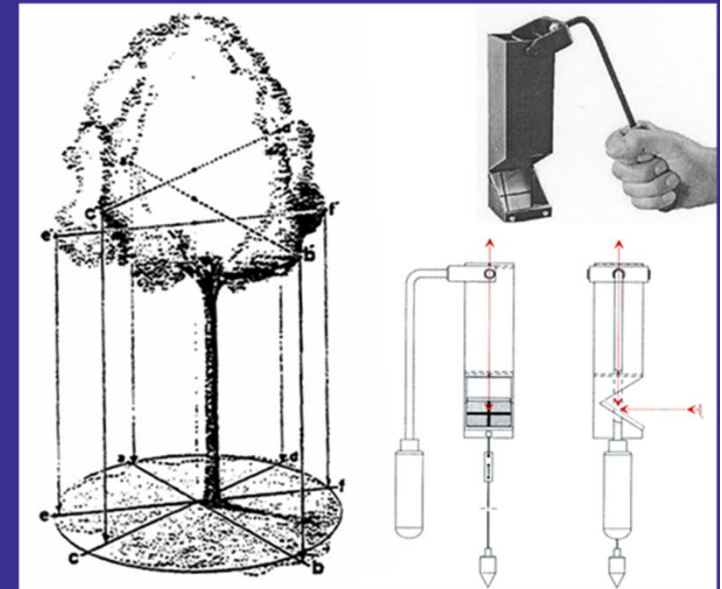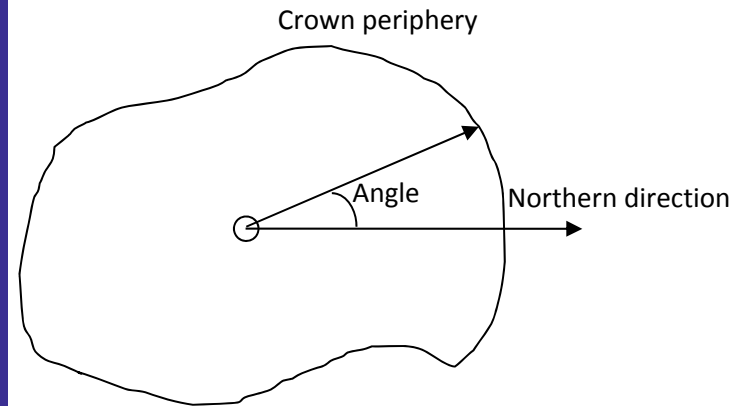
Shape of the projection area is defined by the measured crown radii and edges are used to define a polygon.

Crown radii and the corresponding angles (computed azimuth) in the measured directions (neighbouring or eight cardinal directions) are associated after they have been transformed into polar coordinates regarding tree position coordinate origin.

Sketch of a crown projection

Linear interpolation of neighbouring crown radii yields approximate crown radii to any crown angle and the crown projection shape can be derived.
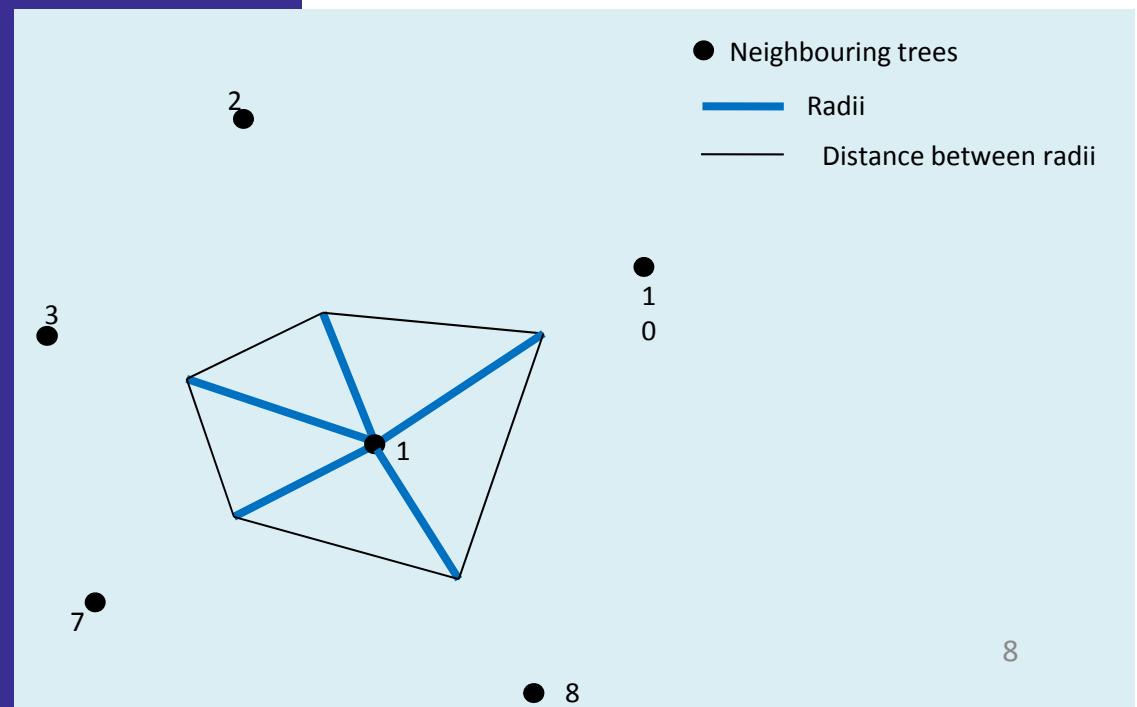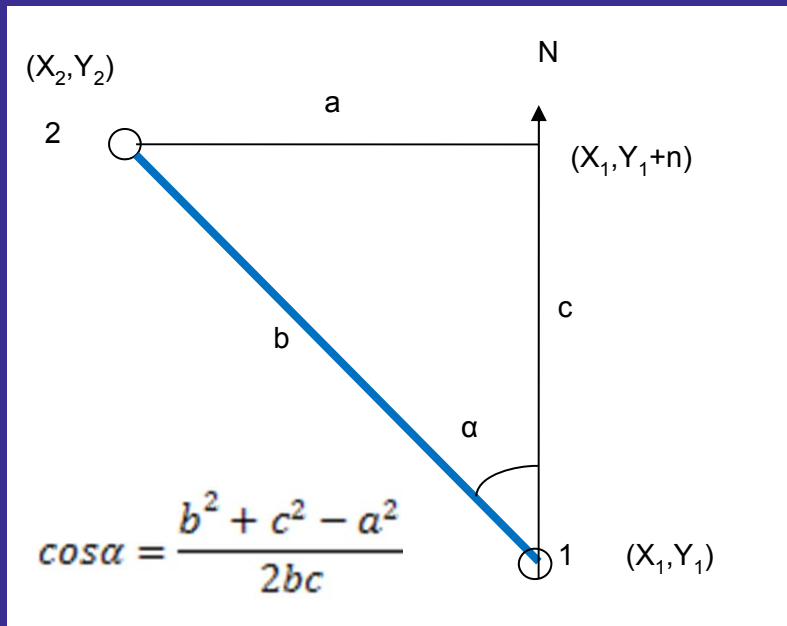
Computation Formula

$$cos\alpha = \frac{b^2 + c^2 - a^2}{2bc}$$

Azimuth with the North direction

With

a: distance between a neighbouring tree and a fixed point in the north direction

b: distance between two neighbouring trees

c: distance between a specific tree and a fixed point in the north direction

Crown projection area (m^2) was computed based on an approximated polygon of n=72 sides

MATERIAL AND METHODS (6/6)

Mean crown radius

$$CR = \sum_{i=1}^{N} r_i^* / N$$

Crown surface

$$CRP = \frac{\pi \cdot CR}{6 \cdot l^2} \cdot \left(\left(4 \cdot l^2 + CR^2\right)^{\frac{3}{2}} - CR^3 \right)$$

Where *l* is the tree height and assuming that crown surface can be assimilated to the geometry of a paraboloid Kramer (1985)

Crown eccentricity

$$CEC = \sum_{i=1}^{N} \frac{\varepsilon_i}{N}$$

with

$$\varepsilon_i = \frac{\sqrt{\left| r_i^{*2} - r_{i-1}^{*2} \right|}}{\max \left(r_i^*, r_{i-1}^* \right)}$$

ANALYSIS AND RESULTS (1/6)

Data analysis

Data collection was based on the total census of all trees within the plot

Software

Microsoft excel (data entry, computation of basic information regarding single tree parameters and azimuth)

BESTAND (Sofware from LFE) was used for the build-up of crown projection maps and the computation of canopy cover percentage

Microsoft access was used to query and retrieve needed information from various tables.

SPSS (statistical analysis using 5% error margin).

ANALYSIS AND RESULTS (2/6)

Years	2011						1999		
	Neighbouring- tree direction			8 main compass direction			Neighbouring- tree direction		
Methods	Average	Min	max	Average	Min	Max	Average	Min	Max
BHD	46,70	29,00	76,40	46,70	29,00	76,40	41,85	26,35	70,25
Height	34,14	23,70	46,70	34,14	23,70	46,70	32,90	25,80	38,40
Height of crown base	15,82	6,45	28,65	15,82	6,45	28,65	NA	NA	NA
Mean crown radius (m) CR	3,72	2,08	5,87	3,88	2,20	6,60	4,10	2,36	7,51
Mean crown projection area(m^2)	51,20	18,40	107,73	55,24	17,47	140,87	57,66	18,07	179,18
Mean crown surface(m^2) CRP	261,44	105,62	761,07	273,11	103,68	807,87	574,67	285,45	1167,94
Number of trees	38			38			38		
Canopy cover percentage	48,19			50,24			47,01		
Canopy cover area (m^2)	1960,7			2044,11			1912,70		
Total crown projection area (m^2)	1945,62			2099,18			2190,89		
Total crown surface (m^2)	9934,68			10378,00			21837,47		

Overviews of compute crown parameters

ANALYSIS AND RESULTS (3/6)

Paired sample t-test reveals significant difference between mean crown radius in the neighbouring direction(3.72 m) and in eight main compass directions (3.88) with p=0.021

Mean crown projection area at the ground level in the neighbouring and in the main compass direction were respectively 51.20 m and 55.24 m and lead to p=0.033
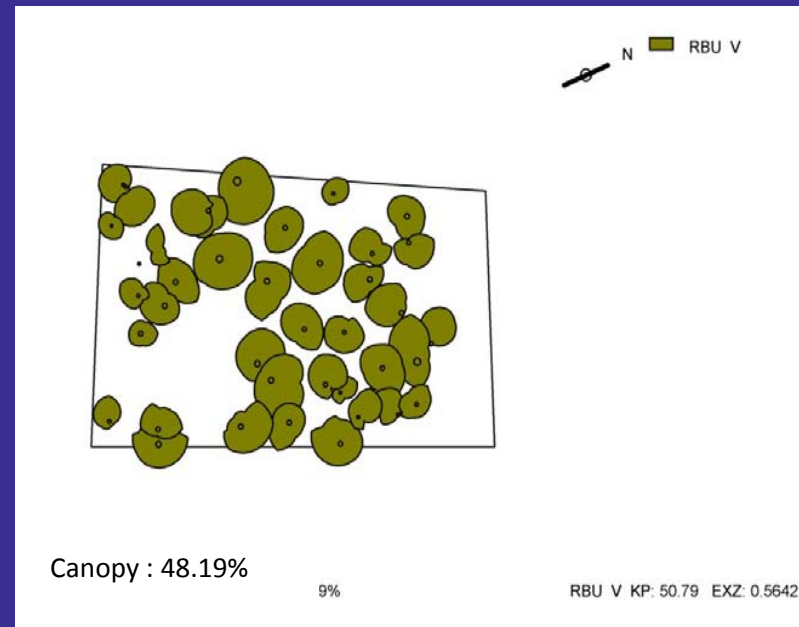
No significant difference was found when comparing means of crown surfaces in the neighbouring crown direction (261.44 m²) and in the eight main compass directions (273,11 m²) with p=0.052

No significant difference was found between crown projection area of remaining trees for 1999 and 2011 (p=0.44)

No diffrence was found between tree heights from 1999 (34.14 m) and 2011 (32.90 m). This is probably because Beech is a slow growth rate specie.
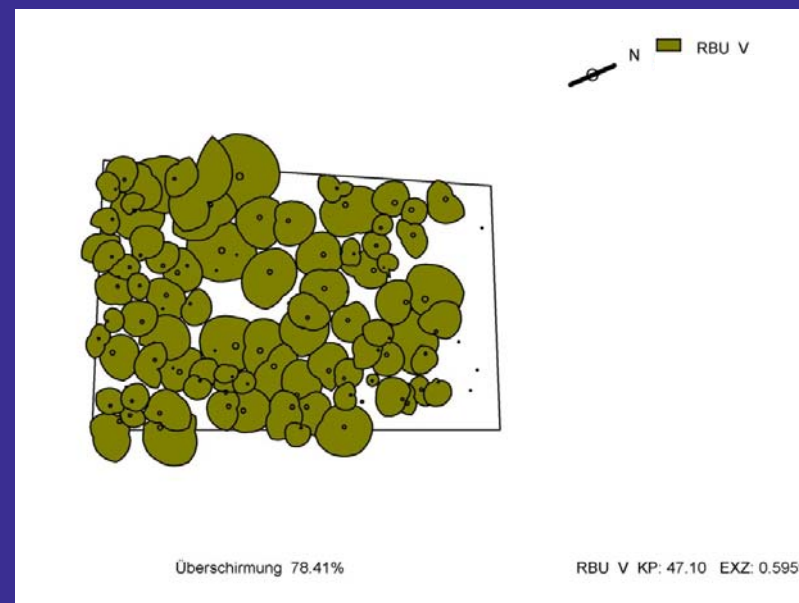
Canopy : 50.24%

RBU V KP: 54.66 EXZ: 0.6210
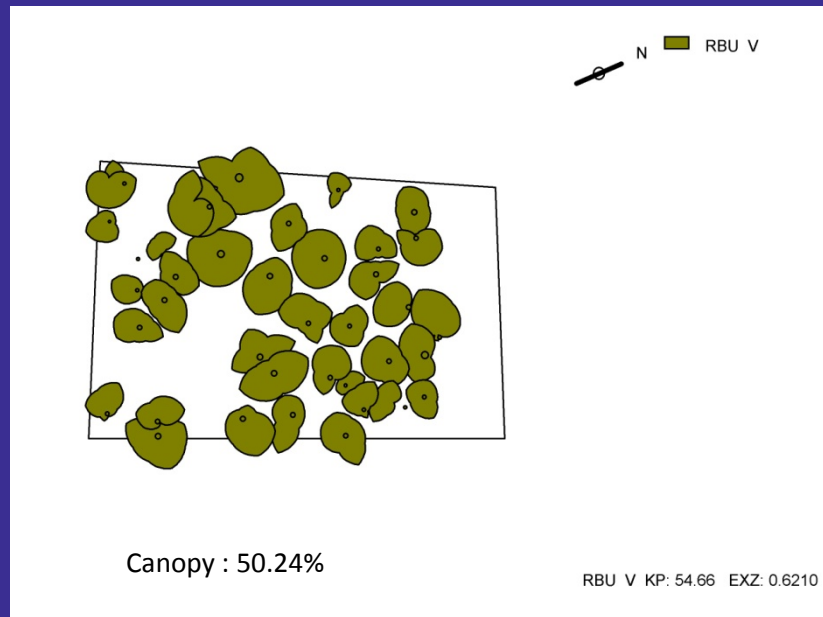
Crown projection map in the 8 compass directions (2011)

Canopy : 48.19%

9%

RBU V KP: 50.79 EXZ: 0.5642

Crown projection map in the neighbouring tree directions (2011)

Canopy : 47.01%

RBU V KP: 57.66 EXZ: 0.5766
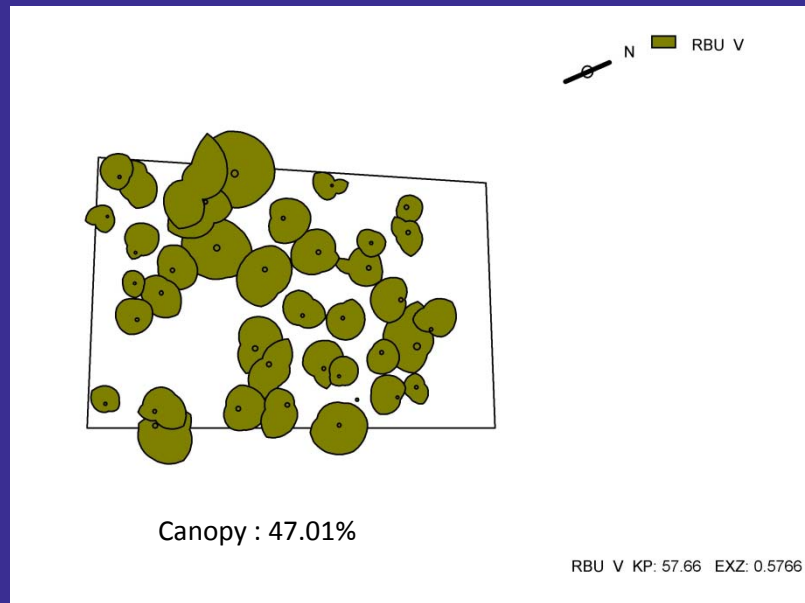
Crown projection map of the remaining trees in the neighbouring tree directions (1999)
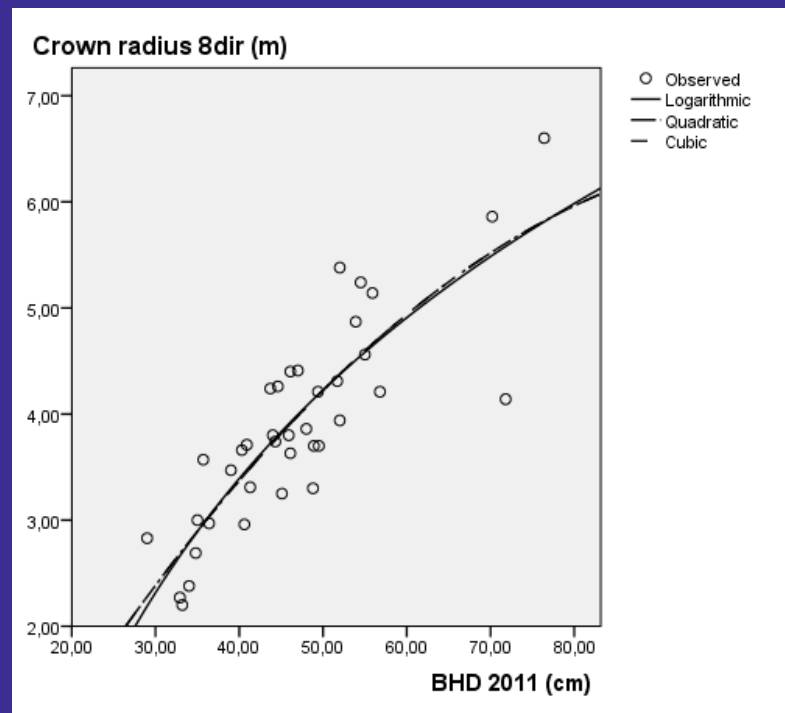

Überschirmung 78.41%

RBU V KP: 47.10 EXZ: 0.5959

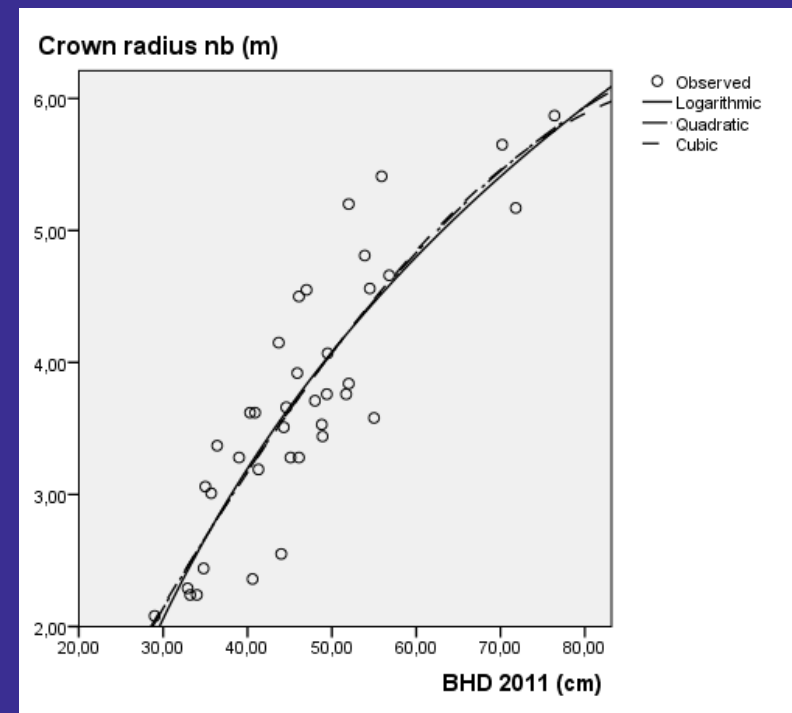Crown projection map in the neighbouring tree directions (1999)

ANALYSIS AND RESULTS (5/6)

Mean BHD goes from 41.85 cm in 1999 to 46.70 cm in 2011. Paired sample t-test reveals that they were different ($p<0.001$)
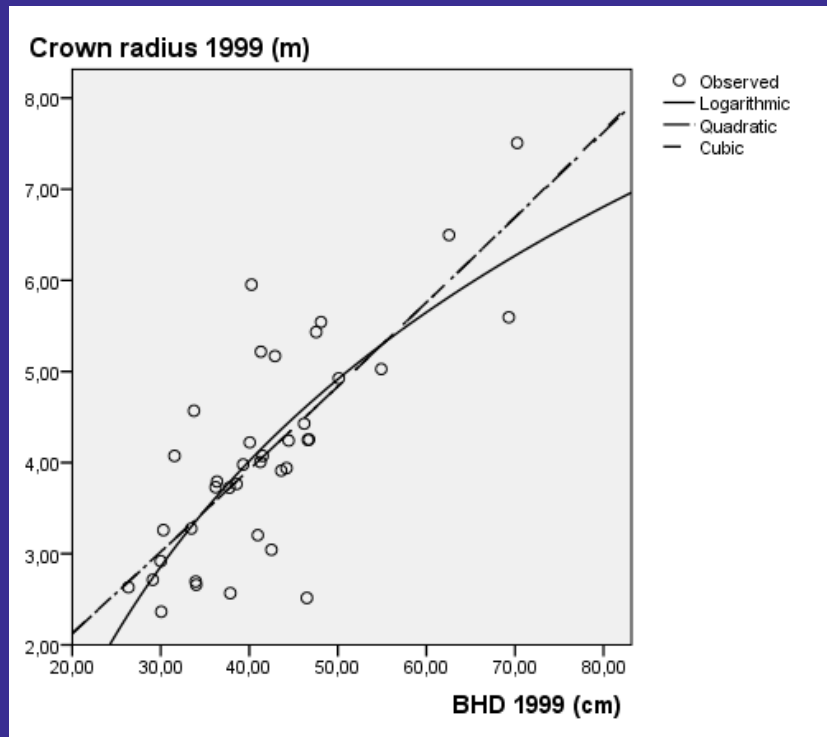
Crown radius and BHD

Relation between crown-radius and BHD in the main cardinal directions for 2011
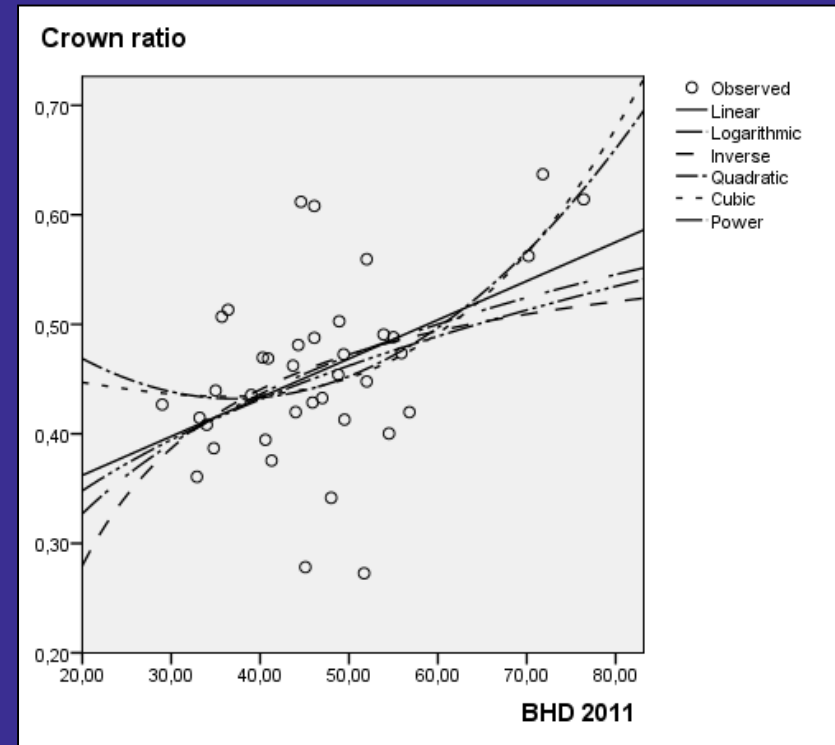R^2= 0.722 (cubic, quadratic and logarithmic)

Relation between crown-radius and BHD in the neighbouring tree directions for 2011
R^2=0.760 (logarithmic) R^2=0.761 (quadratic and cubic)

ANALYSIS AND RESULTS (6/6)

Relation between crown-radius and BHD in the neighbouring tree directions for 1999
R²= 0.591 (Cubic and quadratic)
R²= 0.576 (logarithmic)

Relation between crown-ratio and BHD in the neighbouring tree directions for 2011
No trend can be associated. (0.128≤ R2≤0.266)

DISCUSSION AND CONCLUSION

Measured and computed crown parameters in the neighbouring tree directions are not as big as those in the eight compass directions. This might be due to the fact that in the neighbouring tree directions, trees interact among themselves and this limits crown to extent till a certain limit.

The fact that estimated parameters from 1999 are bigger than those from 2011 also denote the necessity for the method to be improved because following Röhle (1986), different people measuring the same tree can produce different results.

Nowadays aerial photographs are more often used to map and determine the horizontal projection of tree crowns where single tree crowns can be clearly identified. In closed forests it is often a major problem to define the boundary between the crown of a tree and the one belonging to other trees in its vicinity. All these can lead to under or over estimation.

Depending on how dense the forests stand is, it can be very difficult to see the crown hedges through the crown mirror.

Main difficulty

The sample size was too small to derive a meaningful mathematical relationship.

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Thank you for your attention.