Height growth models for young stands of genetically improved Scots pine and silver birch in Latvia

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Background

- Forest growth and yield tables/functions as a common practice to predict growth.
- No incorporation of genetic gain in conventional models → might not take into account outcomes from tree breeding programs (10 – 25 % gain in growth traits)?

- Potential underestimations?

Objective → new growth functions for Scots pine (*Pinus sylvestris*) and silver birch (*Betula pendula*) improved forest reproductive material (FRM) categories ‘qualified’ and ‘tested’

Material and Methods

- Data from open pollinated progeny trials in Latvia:
  - 10 % of best performing families «*Tested*»;
  - remaining 90 % – «*Qualified*»
- At least twice re-measured trials
  - 11 trials of pine
  - 3 trials of birch
- Age range:
  - 3 -46 years for pine
  - 10 – 22 years for birch

Google Earth
Image © 2022 Maxar Technologies

Material and Methods (2)

GADA - generalized algebraic difference approach

CHAPMAN-RICHARDS GADA FUNCTION

$$h = a_1\left(1-\exp(-a_2 t)\right)^{a_3}$$

base equation
(Richards 1959)

$a1 = \exp(X)$
$a3 = b2 + b3 / X$

$$X_0 = 0.5\left((\ln h_0 - b_2 F_0) + \left(((\ln h_0 - b_2 F_0)^2) - 4 b_3 F_0\right)^{1/2}\right)$$

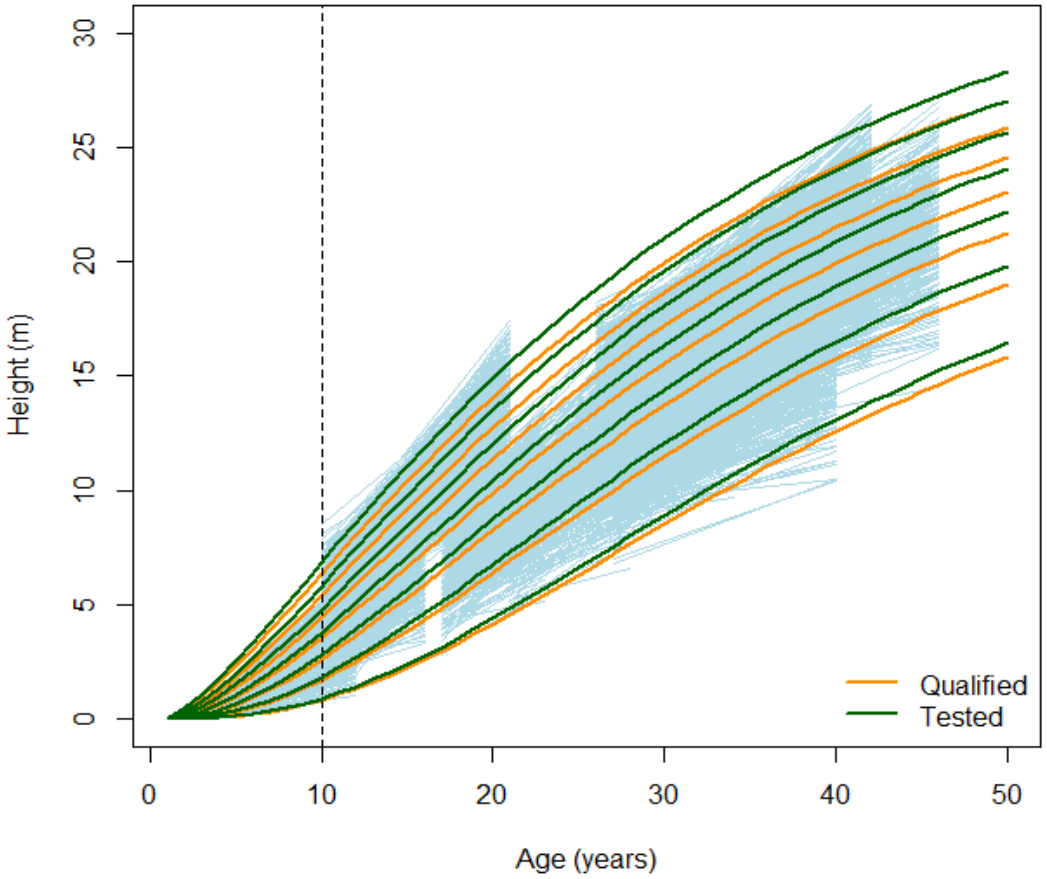
$$F_0 = \ln\left(1 - \exp\left(-b_1 t_0\right)\right)$$

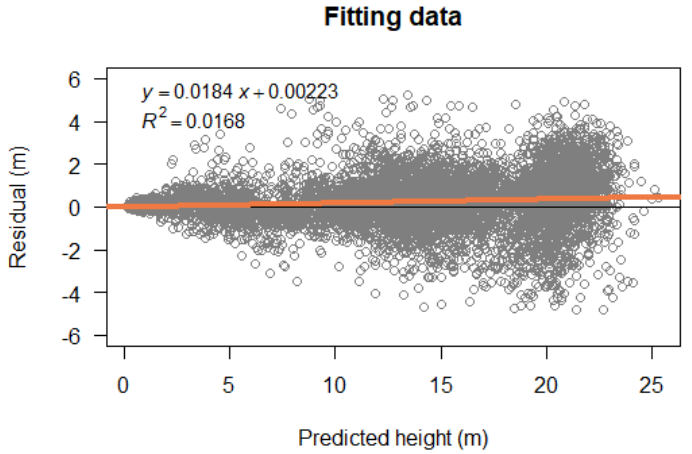
GADA equation (Cieszewski 2004)

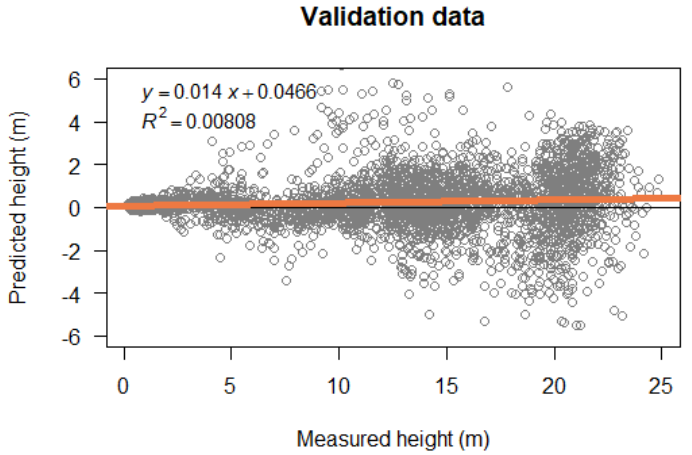
$$h = h_0\left(\frac{1-\exp(-b_1 t)}{1-\exp(-b_1 t_0)}\right)^{(b_2 + b_3 / X_0)}$$

FRM cateogry-specific coefficients

Results: Scots pine







Statistics	RMSE	MEF	N
Fitting data	1.087	0.980	10028
Validation data	1.238	0.975	4271

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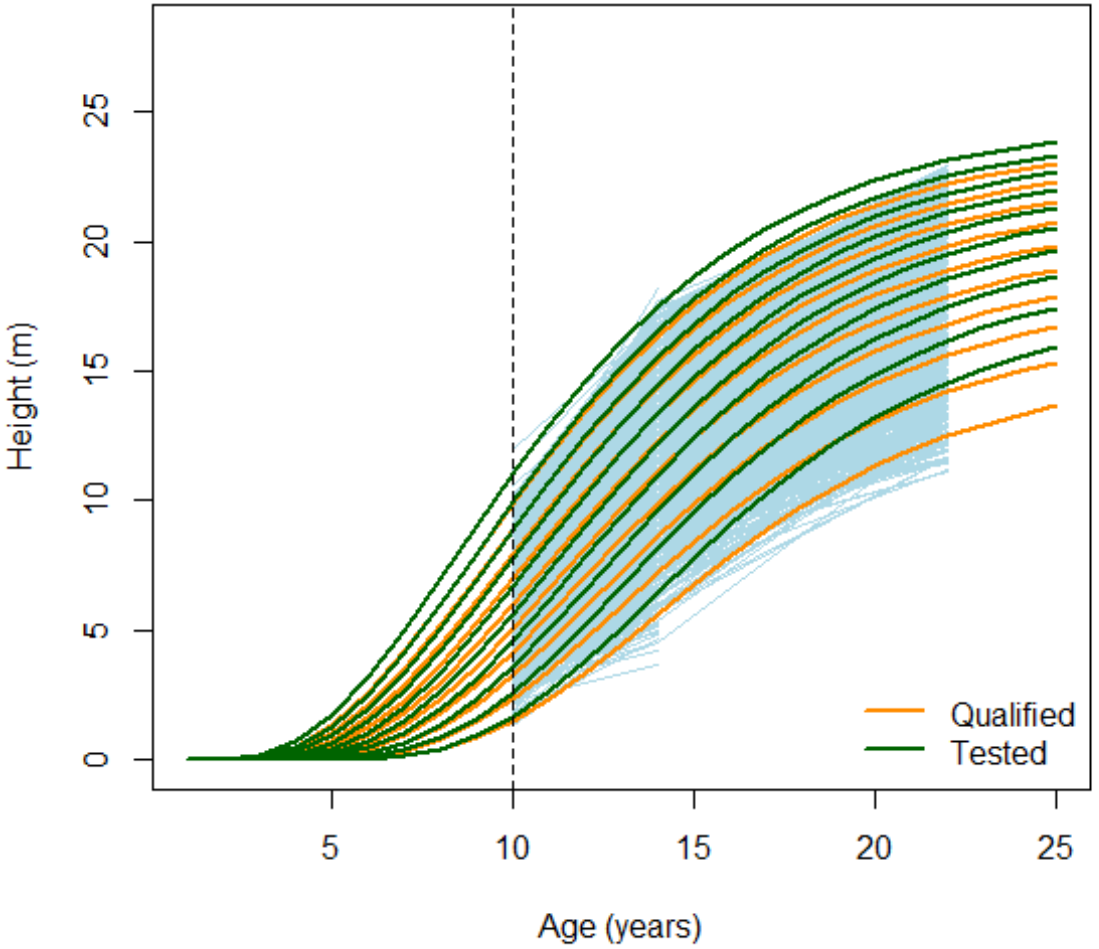
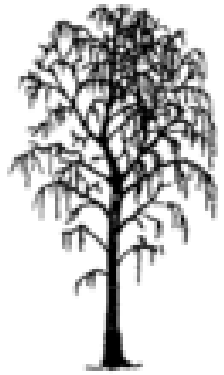
Results: Silver birch





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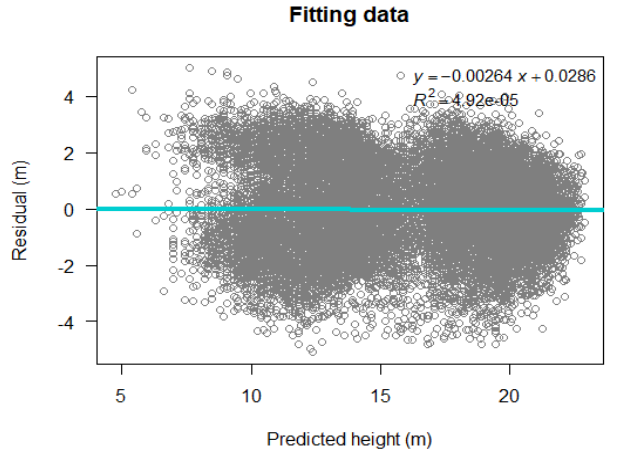
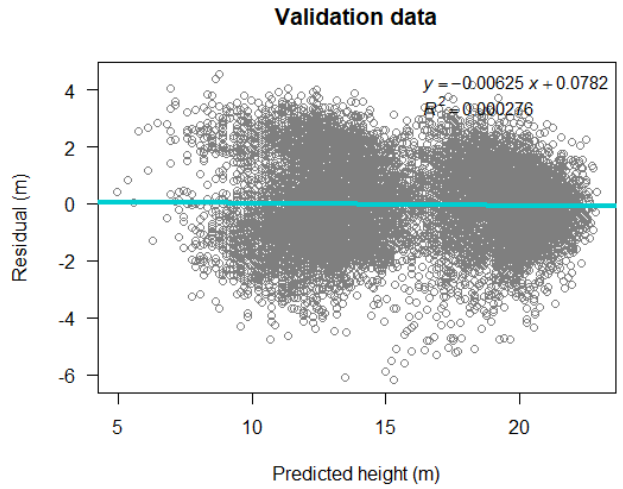
Statistics	RMSE	MEF	N
Fitted.data	1.3642	0.8752	34099
Valid.data	1.3827	0.8717	14618





Results: Scots pine

Incorporation of climate indices from B4EST Climate Downscaling Tool

$$h = h_0 \left(\frac{1-\exp(-b_1 t)}{1-\exp(-b_1 t_0)} \right)^{(b_2 + b_3 / X_0)}$$

unknown environmental effects

substituted with linear function with Mean Temperature of Warmest Quarter and Precipitation of Coldest Quarter:

$b3 = c0 + c1*BIO10 + c2*BIO19$

B4est

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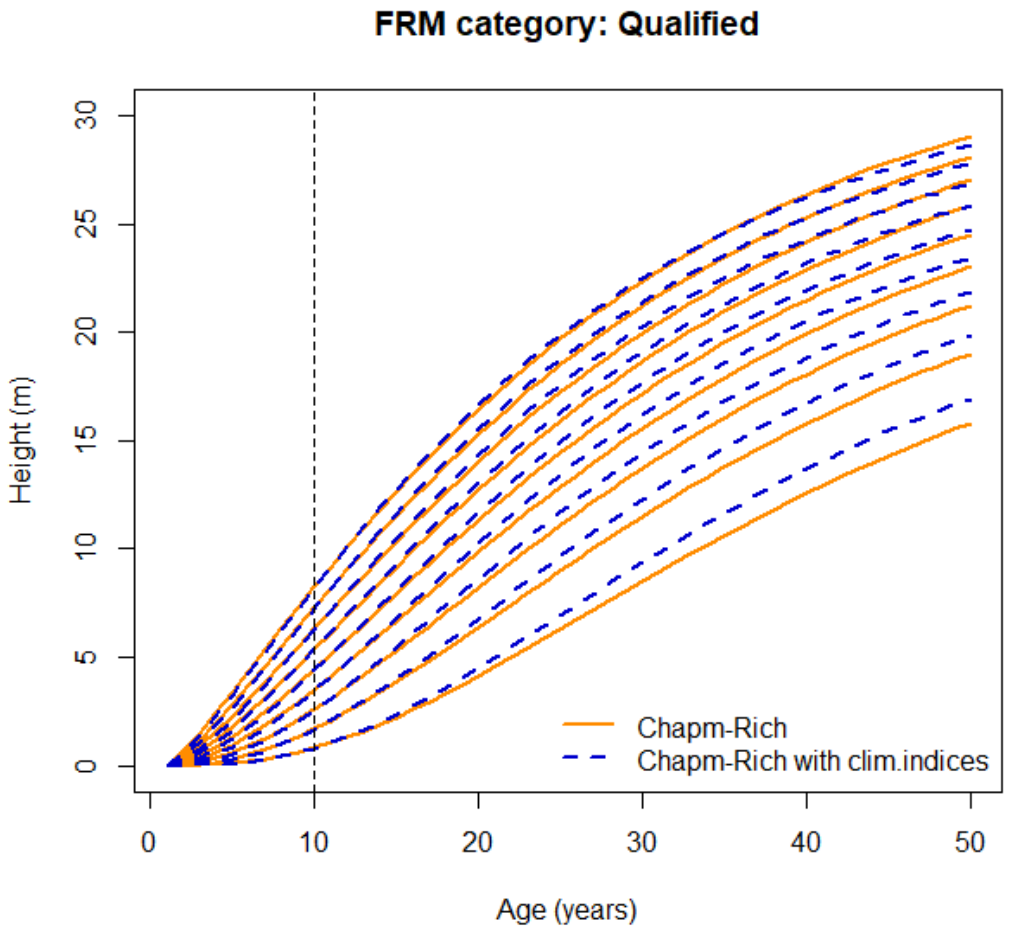
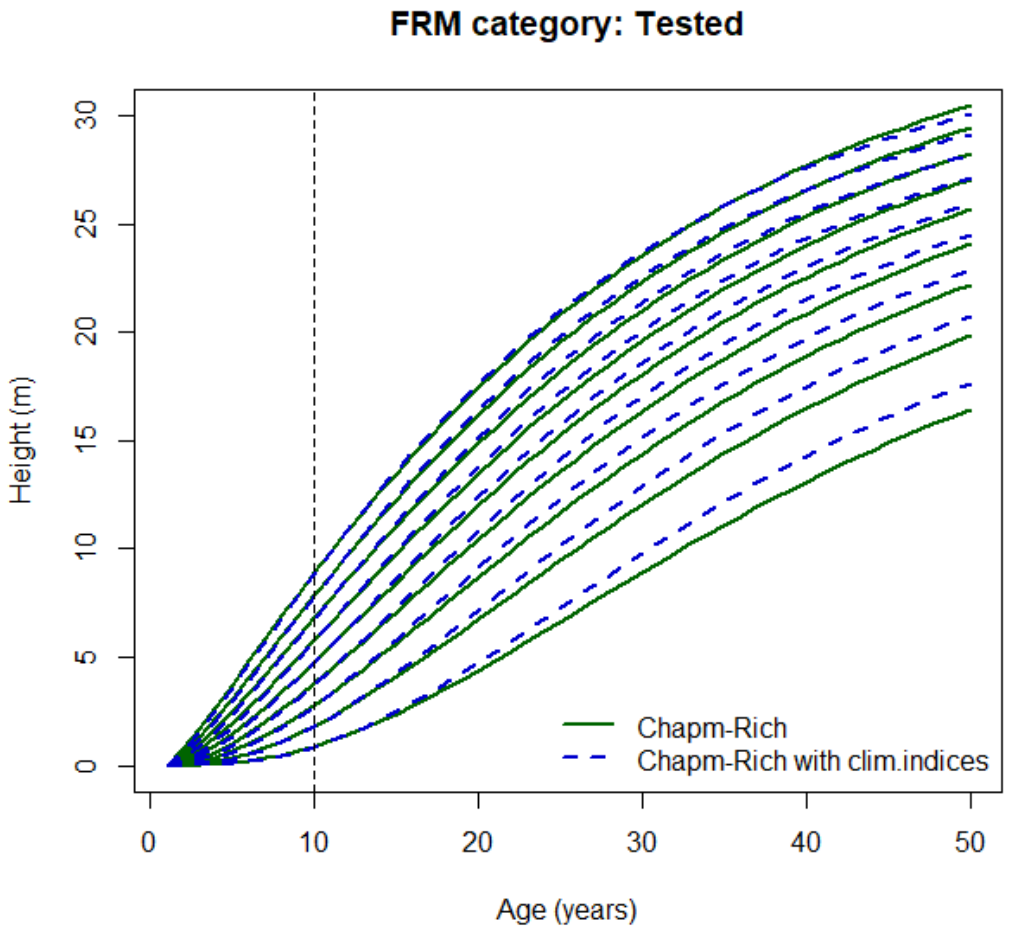
Results: Scots pine





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SOME CONCLUDING REMARKS

- FRM-category specific GADA height growth functions for young stands predicts well height developement for improved Scots pine and silver birch
- Set of coefficients for separate FRM categories

  - easily applicable for practical use

  -more precisely reflect the actual growth of improved stands
- Incorportation of climate indices improves the prediction accuracy and may help to explore potential impact of changing climate on tree height growth

Thank you!

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«Decision support tool for increased forest productivity via efficient climate-adjusted transfer of genetic gain'» (project no. 1.1.1.1/19/A/111)