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Use and prediction

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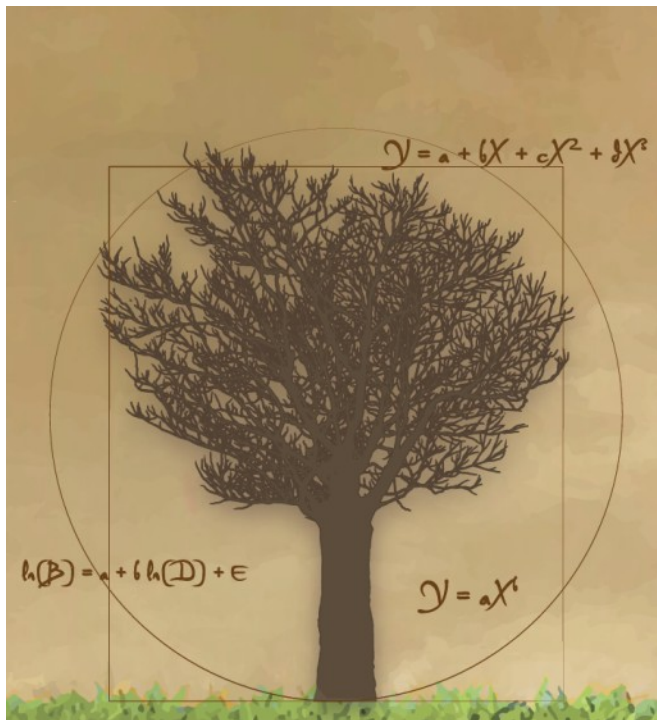
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Submitted on 5 Jun 2020

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Use and prediction



- Dr. Laurent Saint-André,
Gael Sola, Dr. Matieu
Henry, Dr. Nicolas Picard

Training on tree allometric equations,
December 10-14th 2012, Lusaka, Zambia

Using a biomass/volume equation

- ✗ Range of calibration
- ✗ Confidence intervals for the predictions
 - ↳ Linear regression

Confidence interval for the mean

$$\bar{Y}(X) \pm t_{1-\alpha/2} \hat{\sigma} \sqrt{\frac{1}{n} + \frac{(X - \bar{X})^2}{\sum_i (X_i - \bar{X})^2}}$$

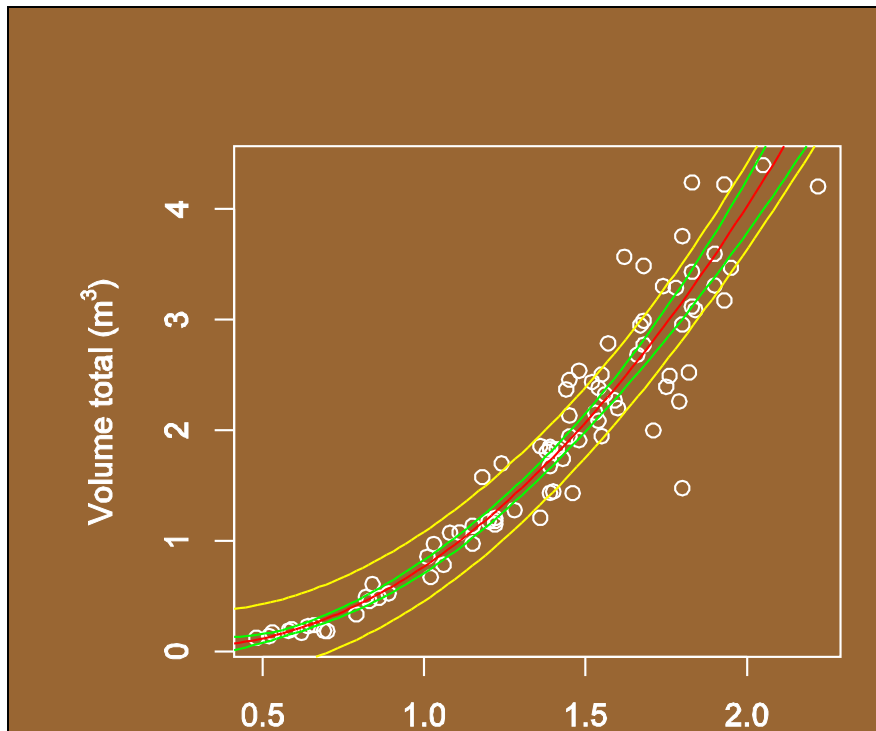
Confidence interval for an individual prediction

$$\bar{Y}(X) \pm t_{1-\alpha/2} \hat{\sigma} \sqrt{\frac{n+1}{n} + \frac{(X - \bar{X})^2}{\sum_i (X_i - \bar{X})^2}}$$

$t_{1-\alpha/2}$ quantile at the level $1-\alpha/2$ for the student law at $n-2$ degrees of freedom

Using a biomass/volume equation

✘ Example: *Isoberlinia doka*



Red – model

Yellow – confidence interval for an individual tree

Green – confidence interval for the mean

Using a biomass/volume

Confidence intervals for the predictions **equation**

General case for linear and non linear regression, utilization of the delta-method (Serfling, 1980)

Confidence interval for the mean

$$\bar{Y}(X) \pm t_{(1-\alpha/2)} \cdot \sqrt{S_y^2}$$

Confidence interval for an individual prediction

$$\bar{Y}(X) \pm t_{(1-\alpha/2)} \cdot \sqrt{S_y^2 + \hat{\sigma}^2 \cdot \hat{\sigma}_{c,c} \cdot X^{\hat{z}}}$$

with : $S_y^2 = \left(\frac{\partial Y}{\partial \beta} \right)' \cdot \hat{\Sigma}_\beta \cdot \left(\frac{\partial Y}{\partial \beta} \right)$ The variance for \bar{Y}

$\left(\frac{\partial Y}{\partial \beta} \right)$ The matrix of the derivative of Y toward the model parameters

$\left(\frac{\partial Y}{\partial \beta} \right)'$ The transposed matrix of $\left(\frac{\partial Y}{\partial \beta} \right)$

$\hat{\Sigma}_\beta$ The covariance matrix of the parameters

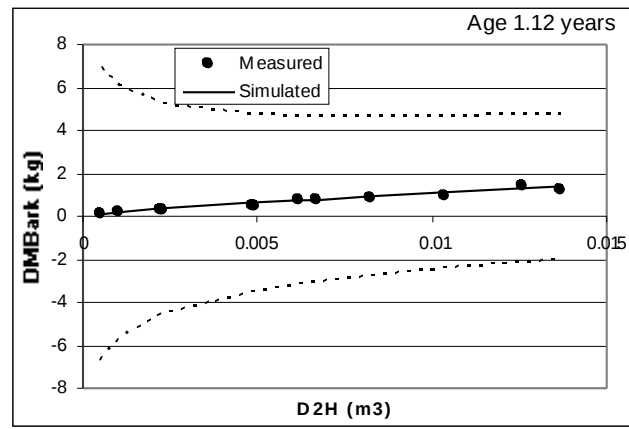
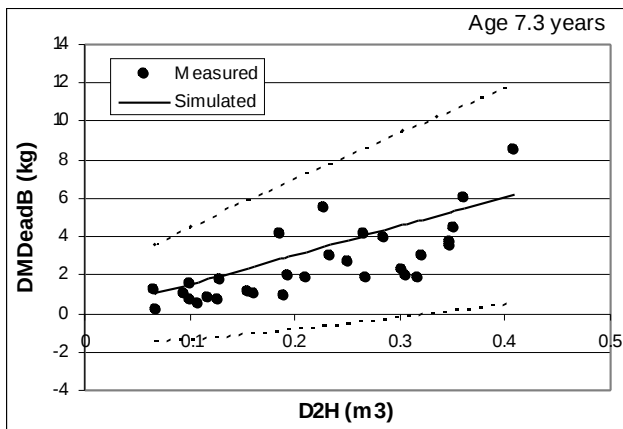
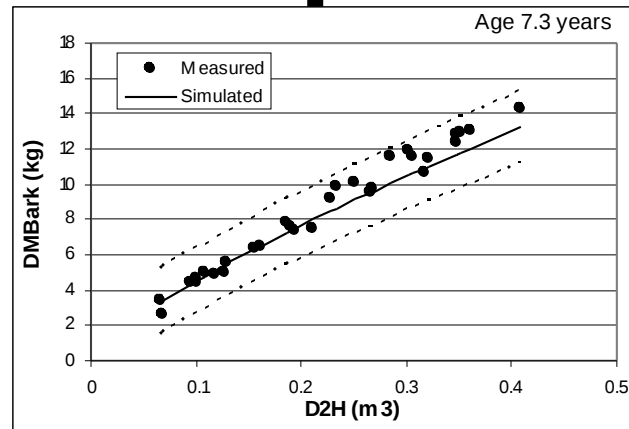
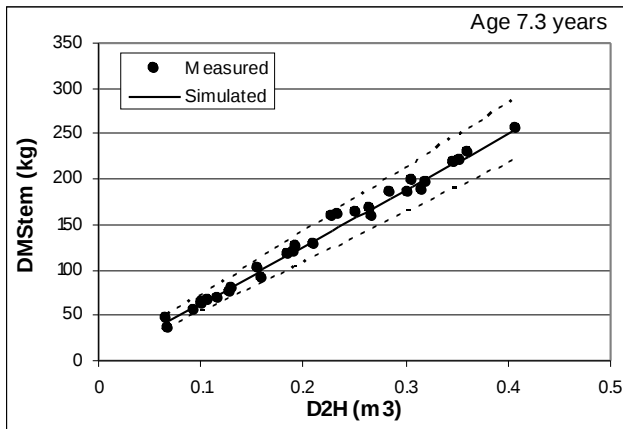
$\hat{\sigma}^2$ The variance of errors of the given compartment

$\hat{\sigma}_{c,c}$ The variance of errors of the given compartment regarding the whole system of equation

$X^{\hat{z}}$ The weighting function

Using a biomass/volume equation

✗ Example : Eucalyptus in Congo (Saint-Angèle et al. 2005)



Using a biomass/volume equation

- From the tree to the stand, Monte-Carlo simulations

equation

$$\varepsilon = N(0, \gamma_1 (d^2 h)^{\gamma_2})$$

Model for variance

$$Y = f(\beta, X) + \varepsilon(\gamma, X)$$

Model for mean

$$\mu = \beta_1 + (\beta_2 - \beta_3 \text{age} + \beta_4 e^{-\beta_5 \text{age}}) d^2 h$$

$$Y = f(\text{input data, parameters, error term})$$

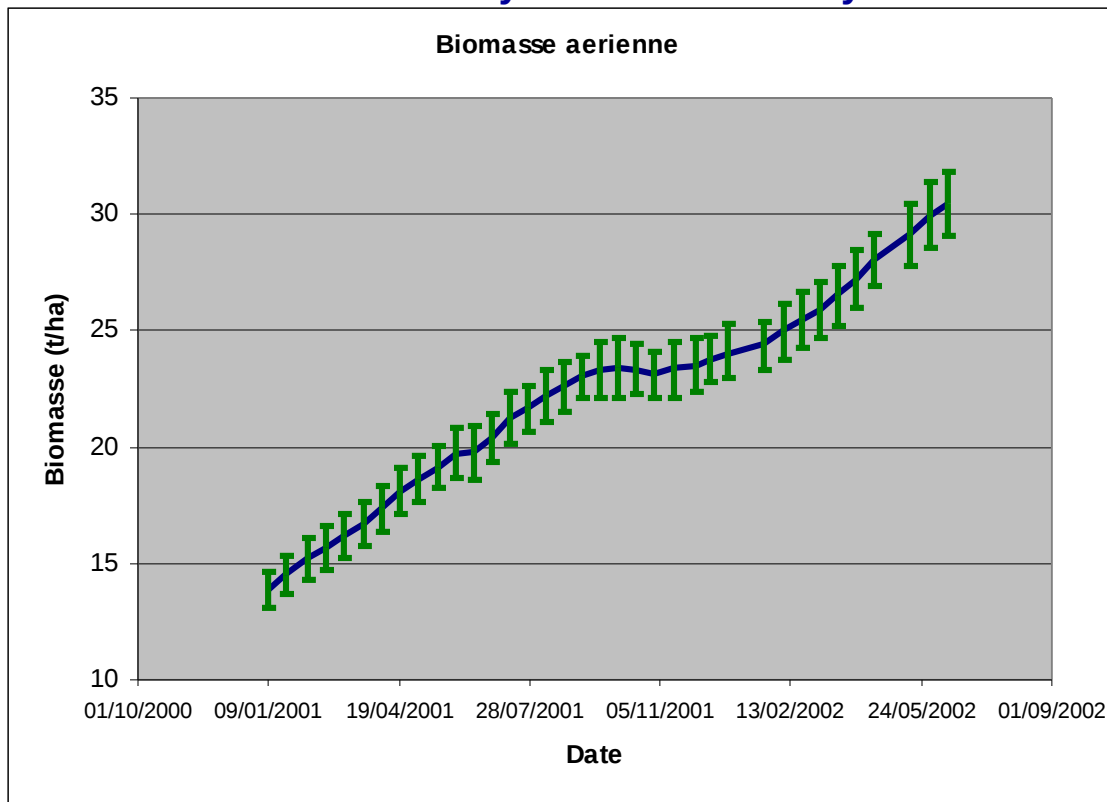
Diameter (d) and height (h). Both contained errors. We assumed that
 $\sigma = 0.3$ cm for diameter
 $\sigma = 3\%$ of height if less than 15 m
 $\sigma = 1$ m if above 15 m

β, γ : estimated by the fitting procedure. We got their mean and their asymptotic standard deviation.
 They are correlated (within a given compartment and between compartments)

Using a biomass/volume equation

- ✗ From the tree to the stand, Monte-Carlo simulations

Only the error term vary

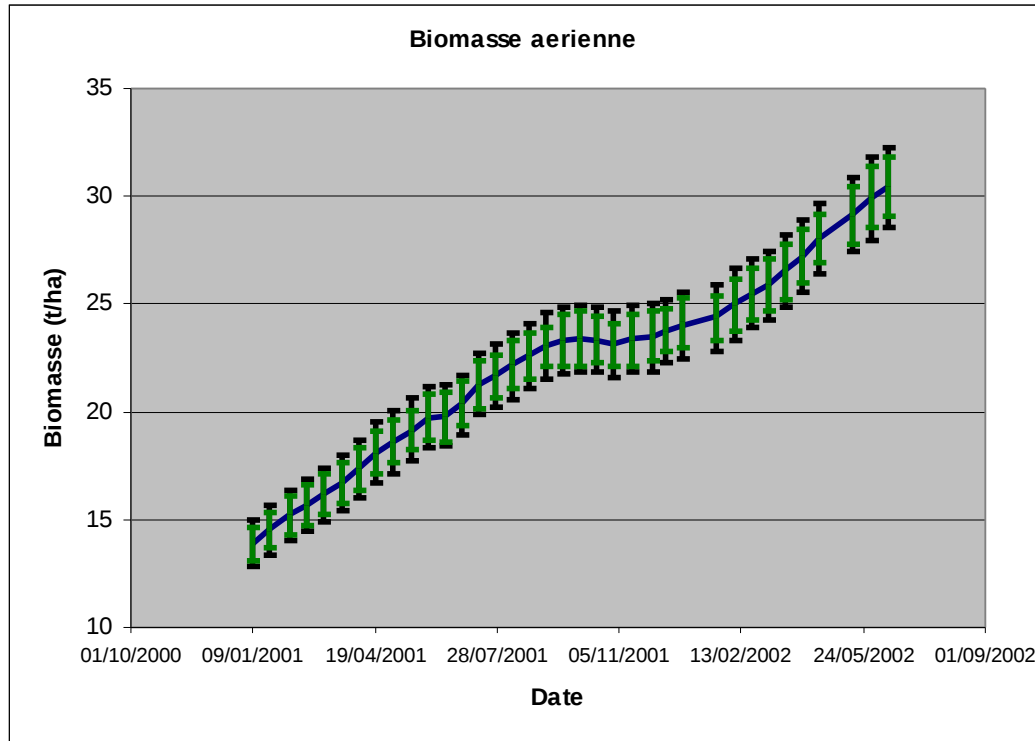


$$Y = a + b.X + N(0, \sigma)$$

Using a biomass/volume equation

- ✗ From the tree to the stand, Monte-Carlo simulations

Error term & parameters of the mean vary



$$Y = a + b.X + N(0, \sigma)$$

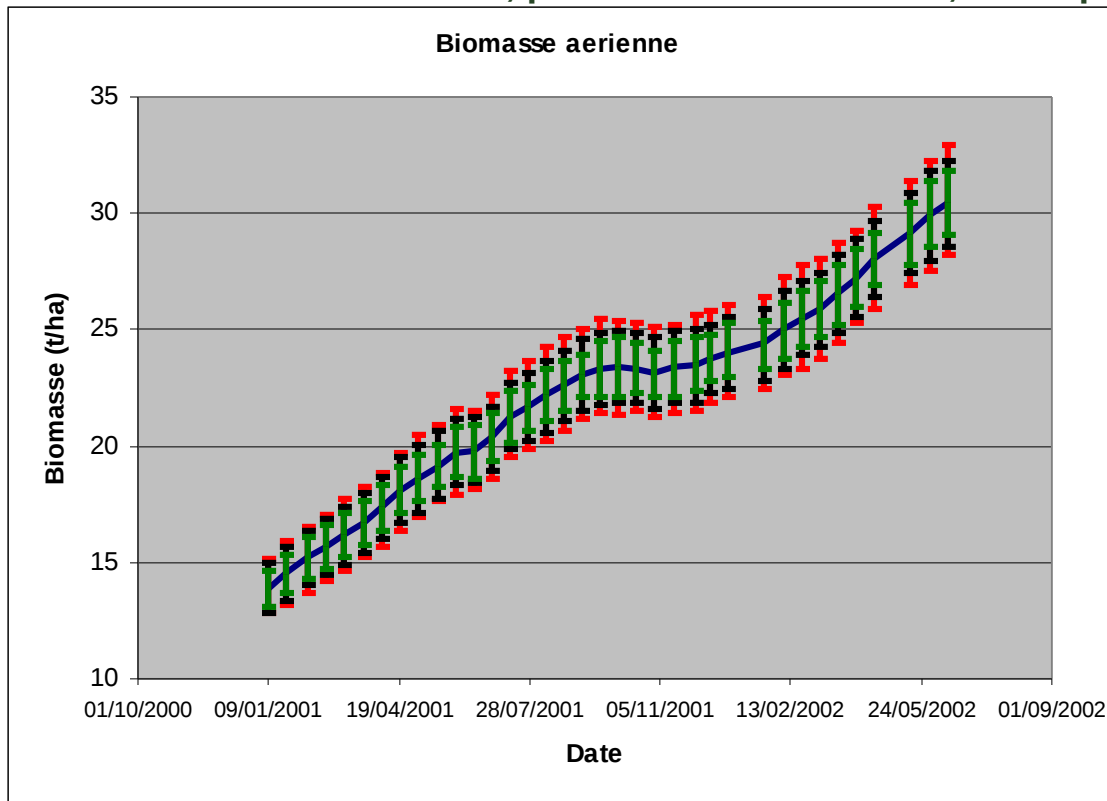
$N(\alpha, \sigma\alpha)$

$N(\beta, \sigma\beta)$

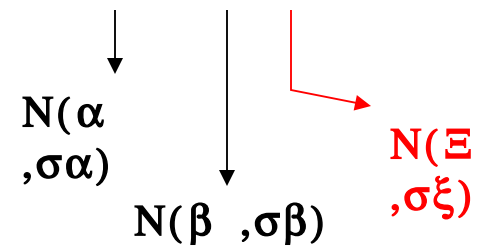
Using a biomass/volume equation

✕ From the tree to the stand, Monte-Carlo simulations

Error term, parameters of the mean, and input data vary



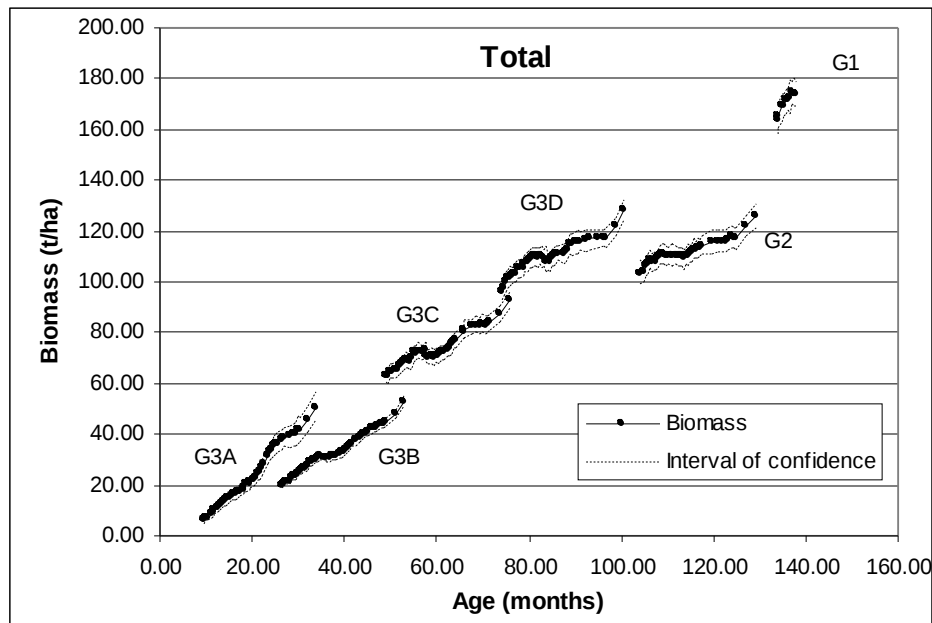
$$Y = a + b.X + N(0, \sigma)$$



Using a biomass/volume equation

✕ From the tree to the stand, Monte-Carlo simulations

For most compartments, standard errors were small with regard to standing biomass (below 10%)



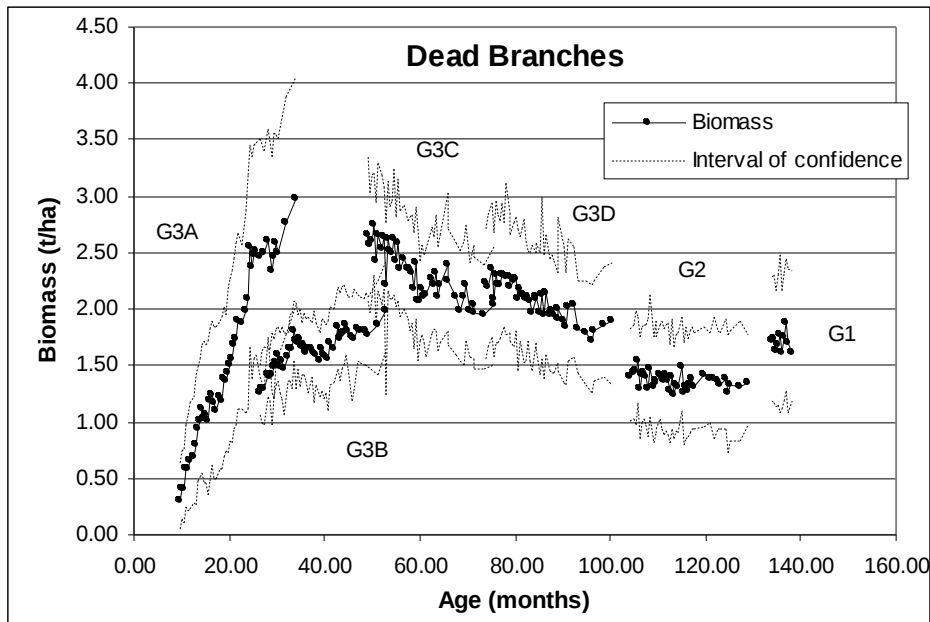
At 100 months :

Total biomass = 128 ± 1.9 t/ha
Above-Ground = 104 ± 1.8 t/ha
Below-ground = 24 ± 1 t/ha

Using a biomass/volume equation

✘ From the tree to the stand, Monte-Carlo simulations

Except for the dead branches biomass (worst model)



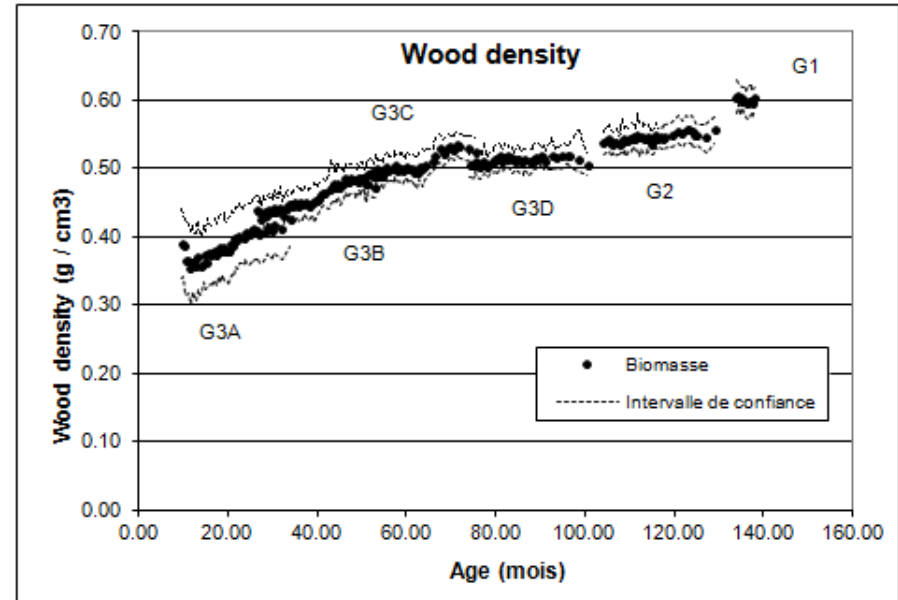
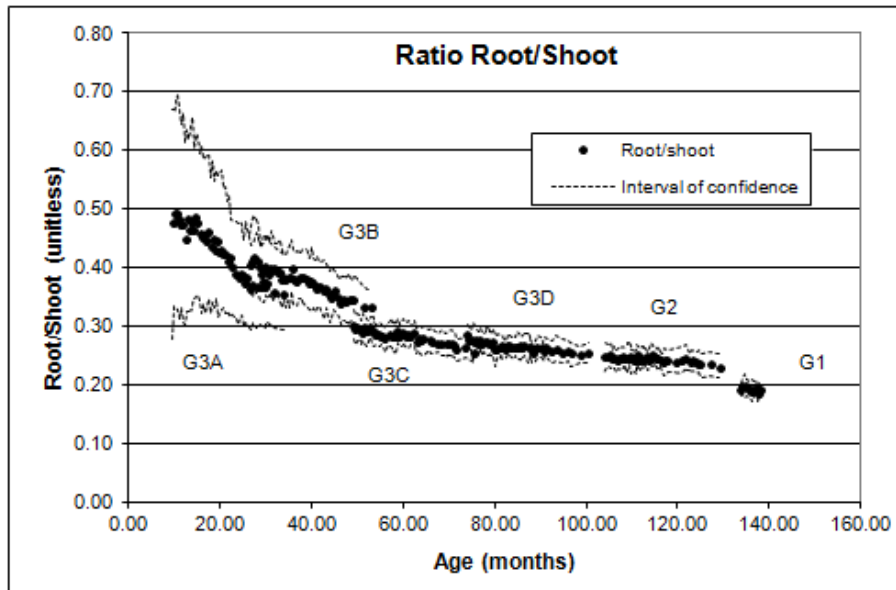
At 100 months :

Dead B = 1.9 ± 0.3 t/ha

Using a biomass/volume equation

✕ From the tree to the stand, Monte-Carlo simulations

Same principles of simulations can be applied also to ratios (root-shoot, wood density, etc.)



Using a biomass/volume equation

✗ From the tree to the stand, Monte-Carlo simulations

Biomass increments

Plot	Age (months)	Year	Start date	End date	Total biomass increment (t/ha)
G3A	9 to 22	2001	23/03/2001	23/03/2002	19.5 ± 1.6
G3A	22 to 34	2002	23/03/2002	02/04/2003	25.6 ± 3.3
G3B	26 to 38	2001	08/01/2001	27/12/2001	12.0 ± 0.9
G3B	38 to 49	2002	27/12/2001	28/11/2002	12.9 ± 1.0
G3C	49 to 61	2001	12/01/2001	11/01/2002	9.6 ± 1.9
G3C	61 to 74	2002	11/01/2002	31/01/2003	15.3 ± 2.4
G3D	74 to 86	2001	13/01/2001	11/01/2002	14.7 ± 2.9
G3D	86 to 99	2002	11/01/2002	31/01/2003	10.9 ± 2.8

Standard errors were relatively large (from 7 to 25 % of the biomass increment)

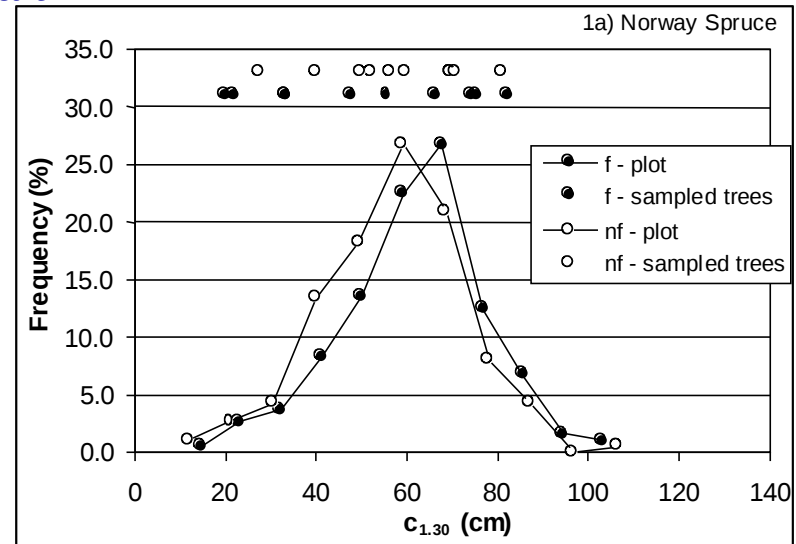
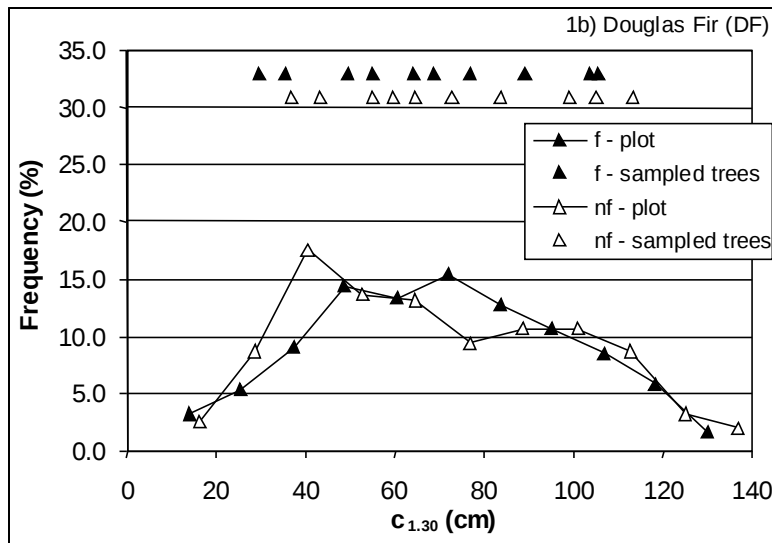
For the eddy-correlation site, $\Delta \text{biomass}_{2002} = \underline{12.9 \pm 1.0 \text{ t/ha/year}}$

Using a biomass/volume equation

✘ Behind the single estimation of biomass, the importance of the ecosystem functioning

Example Sicard et al. 2005 (accepted in Trees, Structure and Function).
Fertilization effect on Spruce and Douglas fir

Step 1 : analysis of the bar chart

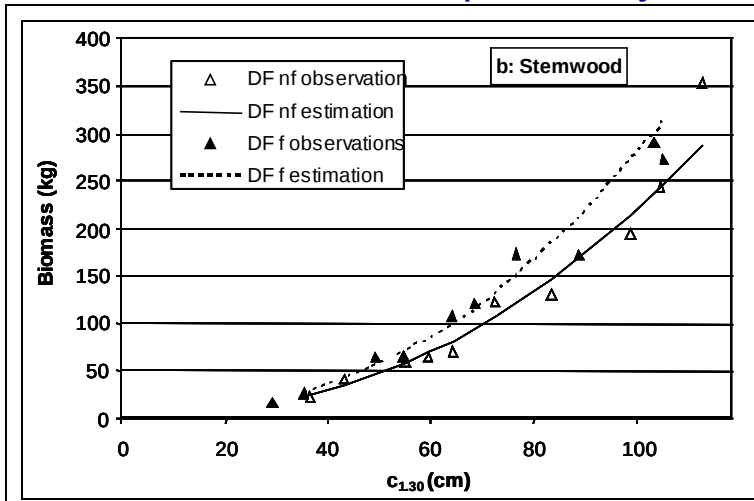


Using a biomass/volume equation

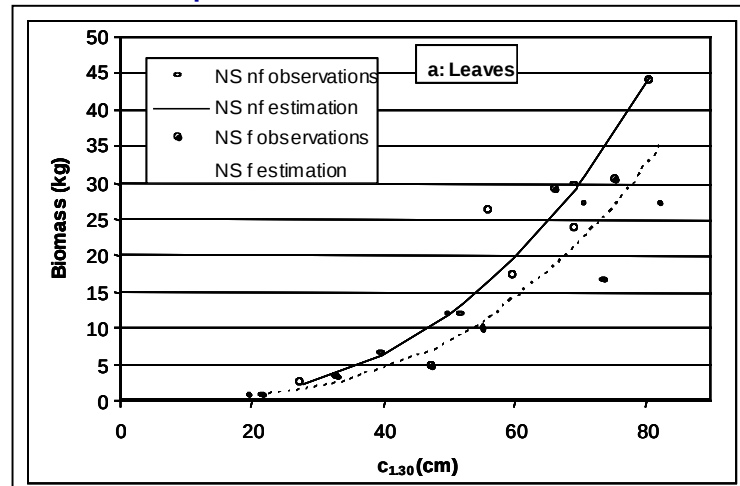
✘ Behind the single estimation of biomass, **the equation** understanding of the ecosystem functioning

Example Sicard et al. 2005 (accepted in Trees, Structure and Function).
Fertilization effect on Spruce and Douglas fir

Step 2 : analysis of the biomass equations



Douglas differences are only significant for the TRUNK



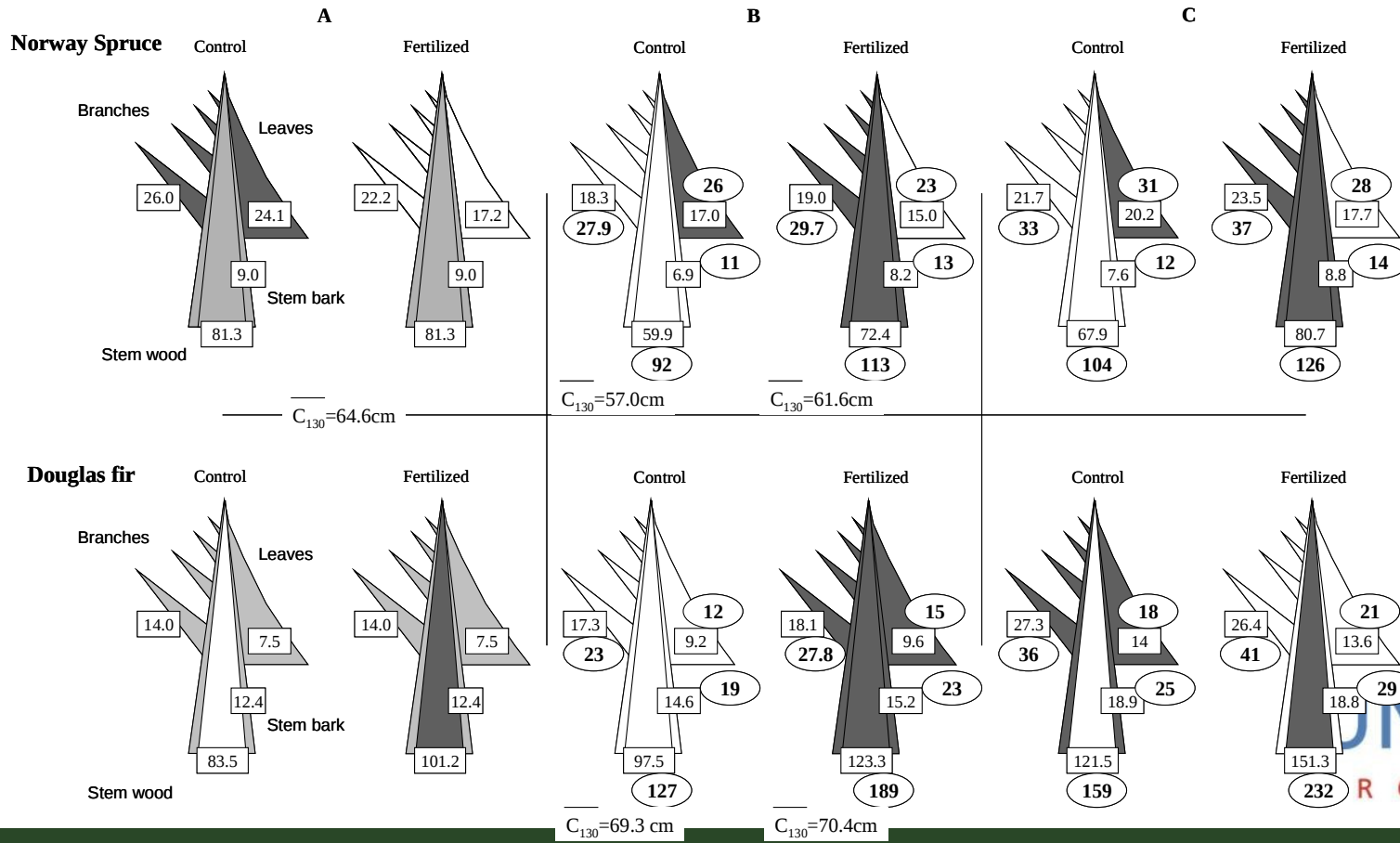
Spruces differences are only significant for the LEAVES

Using a biomass/volume equation

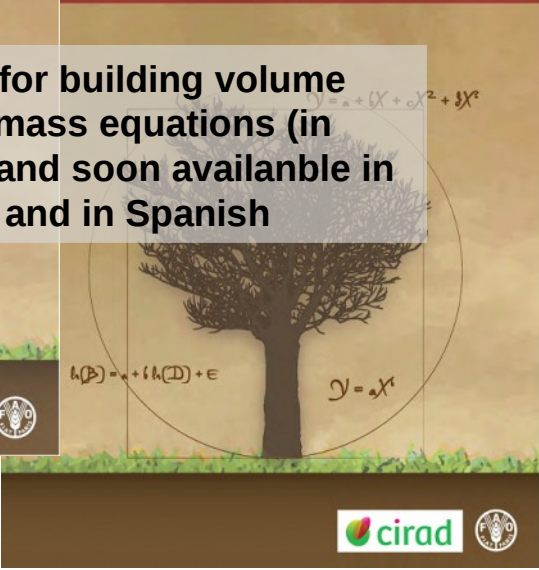
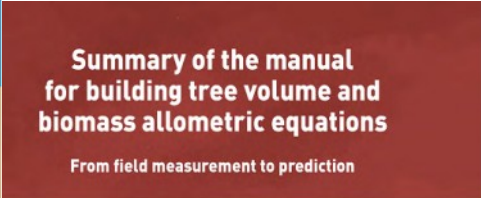
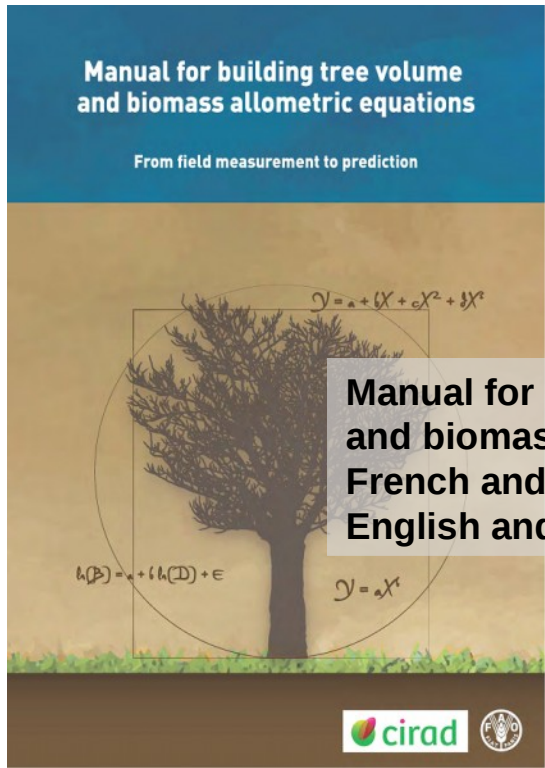
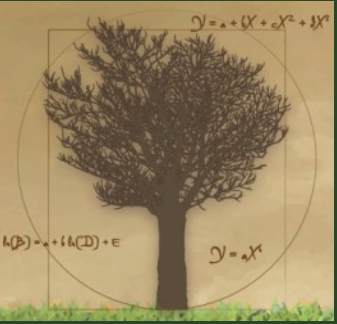
✗ Behind the single estimation of biomass, the importance of the ecosystem functioning

equation

Step 3 : decomposition of the fertilization effect on a per hectare basis



Additional Resources



Manual for building volume and biomass equations (in French and soon available in English and in Spanish)



Project no. 037132
CARBOAFRICA
 Quantification, understanding and prediction of carbon cycle, and other GHG gases, in Sub-Saharan Africa
 Sixth Framework Programme of European Commission
 Priority 1.1.6.3: Global Change and Ecosystems
 STREP (Specific Targeted Research Project)

Literature review on current methodologies to assess C balance in CDM Afforestation/reforestation projects and a few relevant alternatives for assessing water and nutrient balance, as a complement to carbon sequestration assessments.

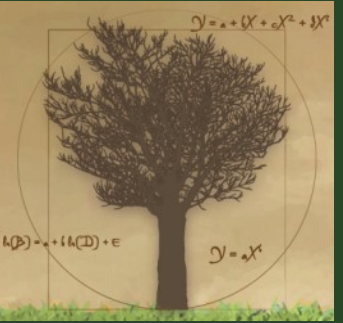
Actual submission date: 05/11/2007

Start date of project: 01/10/06
 Organisation name of lead contractor for this deliverable: CIRAD
 Duration: 3 years
 Revision [1]

Project co-funded by the European Commission within the Sixth Framework Programme (2002-2006)		
Dissemination Level		
PU	Public	PU
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

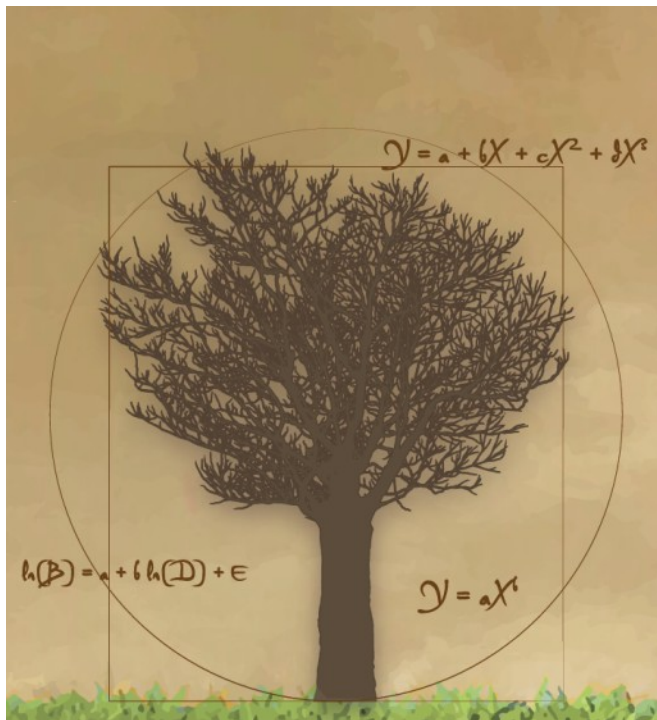


Many thanks to....



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Use and prediction



- Thank you for your attention,
- Any question ?

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