Allometric equations for biomass estimations in Cameroon and pan moist tropical equations including biomass data from Africa

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INTRODUCTION

Moist tropical forests in Africa and elsewhere store large amounts of carbon and need accurate allometric regressions for their estimation. In Africa the absence of species-specific or mixed-species allometric equations has lead to broad use of pan moist tropical equations to estimate tree biomass. This lack of information has raised many discussions on the accuracy of these data, since equations were derived from biomass collected outside Africa.

METHODS

-Biomass data were obtained from felled trees collected in 2000 during the main dry season in three sample plots of 10 m x 10 m. Trees were sectioned and weighted fresh in the field, then oven dried in the lab at 60 °C to obtain the moisture content (MC). The MC of samples enables to deduce the MC in each section of the tree. Hence, it was then possible to obtain dry mass of each section of trees using the formula dry weight = fresh weight – moisture weight.

-Mixed-species regression equations with 71 sample trees using different input variables such as diameter, diameter and height, product of diameter and height, and wood density were developed to estimate total aboveground biomass and biomass of leaves and branches for a Cameroon forest. Our biomass data were added to 372 biomass data collected across different moist tropical forests in Asia and South America to develop new pan moist tropical allometric regressions. Species-specific and mixed-species height diameter regression models were also developed to estimate heights using 3833 trees.

- To account for heteroscedasticity of data, the coefficients a and b of the regression equations were obtained through the least-square regression of log-transformed data for D and M with the value of M obtained from destructive sample trees, i.e. $\ln(M) = \ln(a) + b\ln(D)$. This transformation introduces a systematic bias on the original scale which was corrected with a correction factor *CF* depending on the residual standard error. For these estimations, we tested in total 14 models.

RESULTS

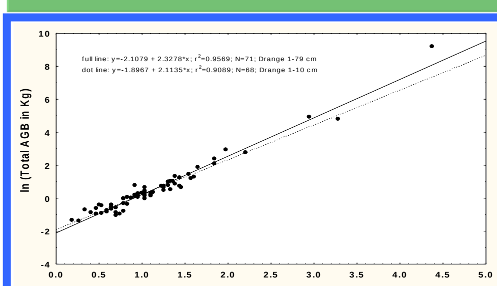

Fig. 1. *Regression between the logarithm of total aboveground biomass in kg and the logarithm of diameter at breast height (D) in cm of 71 trees from our study site.*

Table 1: *Regression analysis from tested models for estimation of relationship between tree height and diameter. a, b and c are the model's fitted parameters; R.S.E is the residual standard error, R the correlation coefficient, N the sample size and AIC the Akaike Information Criterion.*

Equation type	a	b	c	N	R.S.E	R	D-range	AIC
$\ln(H)=a+b\ln(D)$	1.051	0.635	-	3833	0.294	0.7895	5-170	1497
$\ln(H)=a+b\ln(D)+c\ln(D^2)$	1.008	0.493	0.216	3833	0.294	0.7898	5-170	1499
$\ln(H)=a+b/D$	3.610	-11.206	-	3833	0.321	0.7426	5-170	2171

RESULTS Contd..

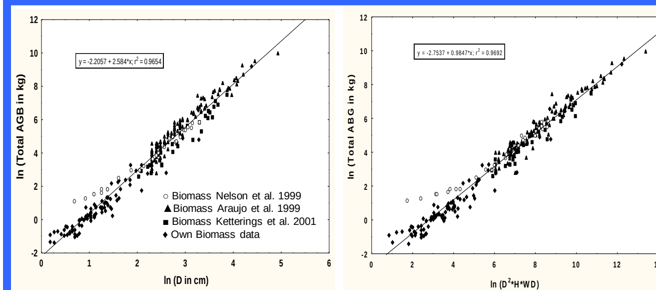

Fig. 2: *Regression between logarithm of total aboveground biomass and of diameter (left); the logarithm of product of square diameter, height and wood density.*

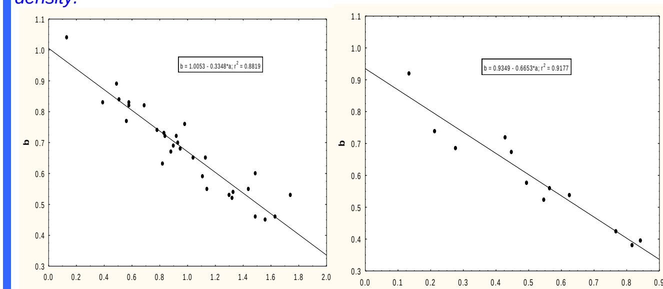

Fig. 3. *Scatter plot showing the relationship between b and a in the height diameter allometric equation with the model ln (H) = a + b ln (D). This paper input (left). Input from Nogueira et al. 2008 (right).*

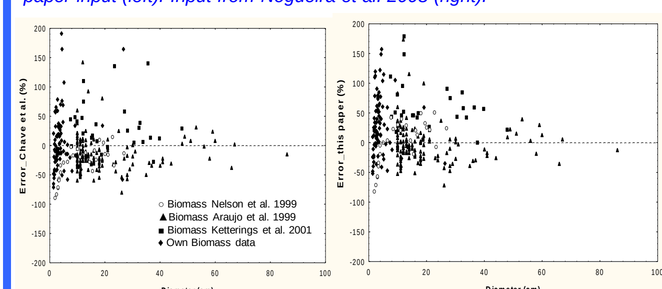

Fig. 4. *Error of 2 published pan moist tropical equations from different data source. Tendency to underestimate or overestimate is indicated by the distance above or below 0% line.*

CONCLUSION

•Mixed-species regression equations provide good estimates of total aboveground biomass of the Campo Ma'an forest when using only diameter as input variable with an average error of 7.4 %. Including height in the model has not improved the precision of the model and having the three variable diameter, height and wood density has improved the precision to 3.4 %.

•It should be kept in mind when using allometric equations that many sources of errors are possible.

•In the absence of species-specific allometric equations or mixed-species allometric equations at a given site, general allometric equations are an appropriate alternative.

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