Biomass & forest inventory

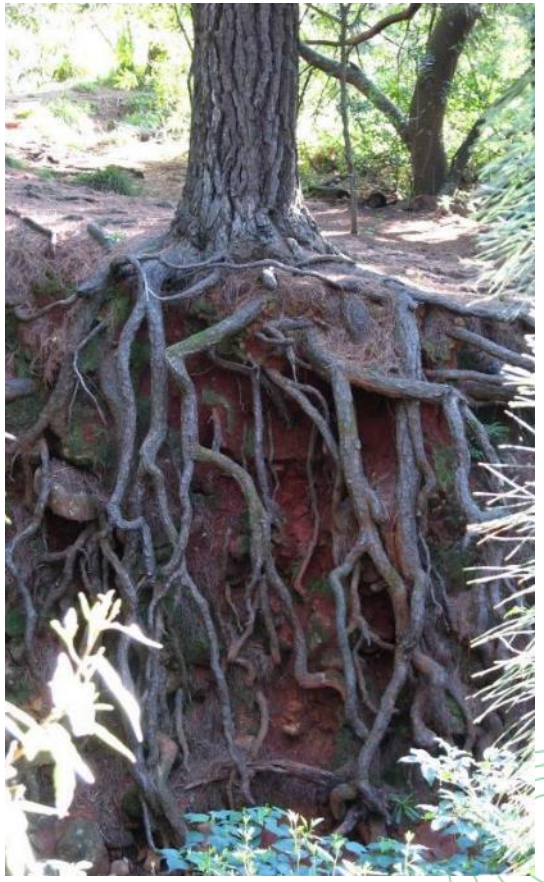
Method of inventory and calculation of biomass

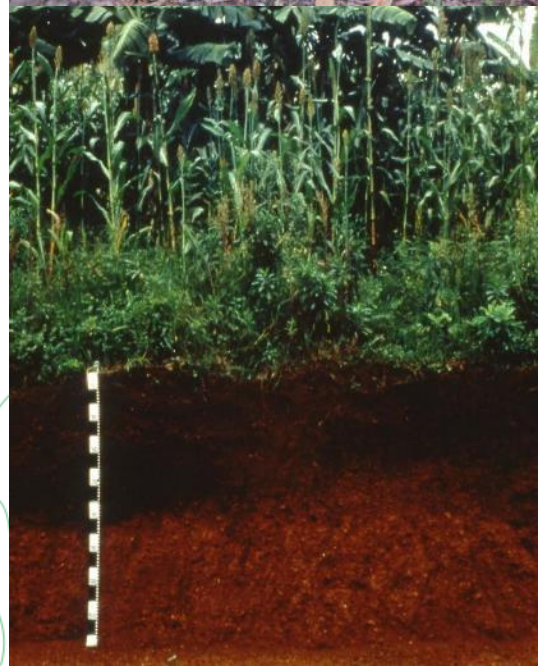
Training from the FORAE Project

Marie Nourtier – 26-07-18

Forest – a carbon reserve

- Different pools containing carbon stocks
  - **Trunks**
  - **Branches**
  - Leaves
  - **Roots**
  - Litter
  - Dead wood
  - **Soil**





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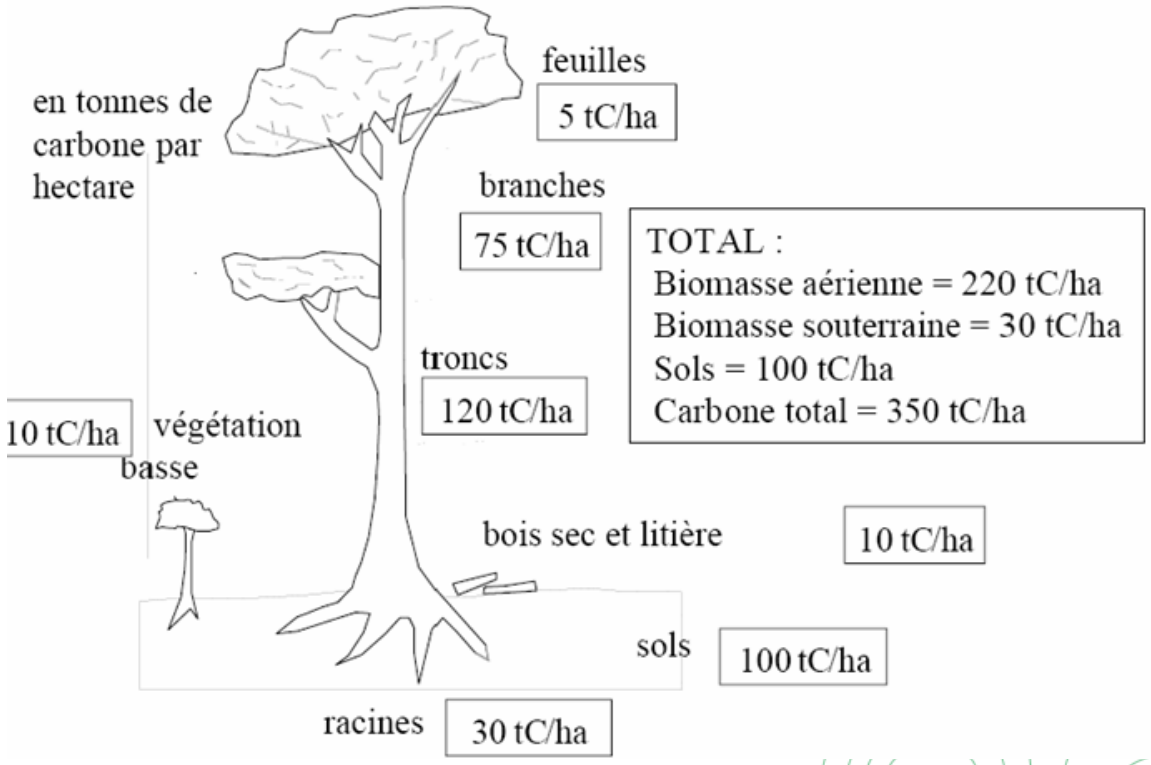
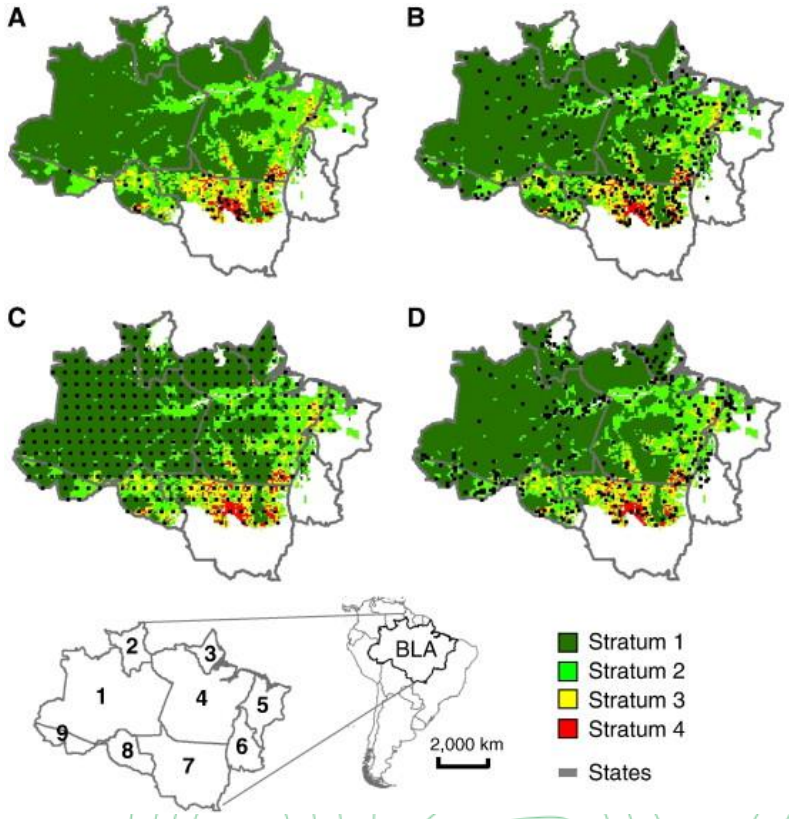


Stratification before inventory

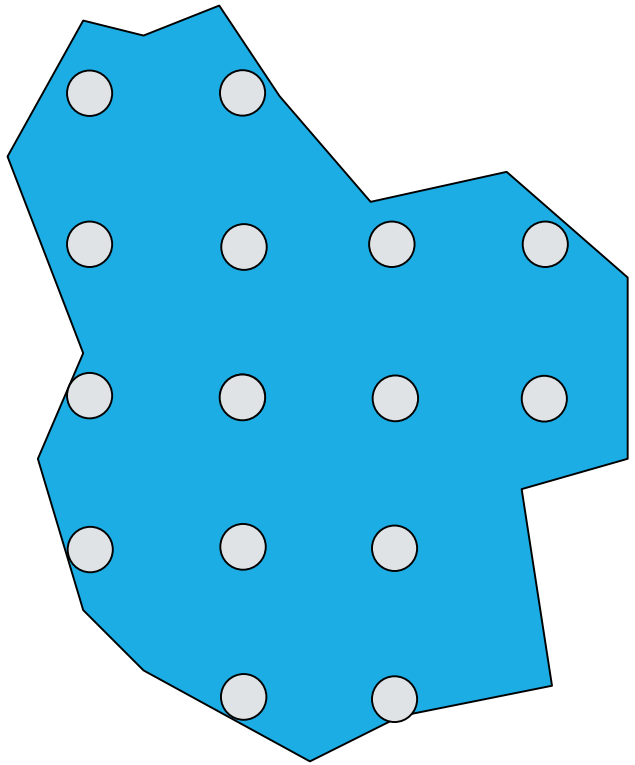
- Divide your forest area into zones with the same characteristics in terms of carbon stocks or composition (biodiversity) according to
  - State of forest : degraded forest, regeneration, mature forest, etc.
  - Floristic composition
  - Soil types and/or topography (fertility)
  - Climate
  - …

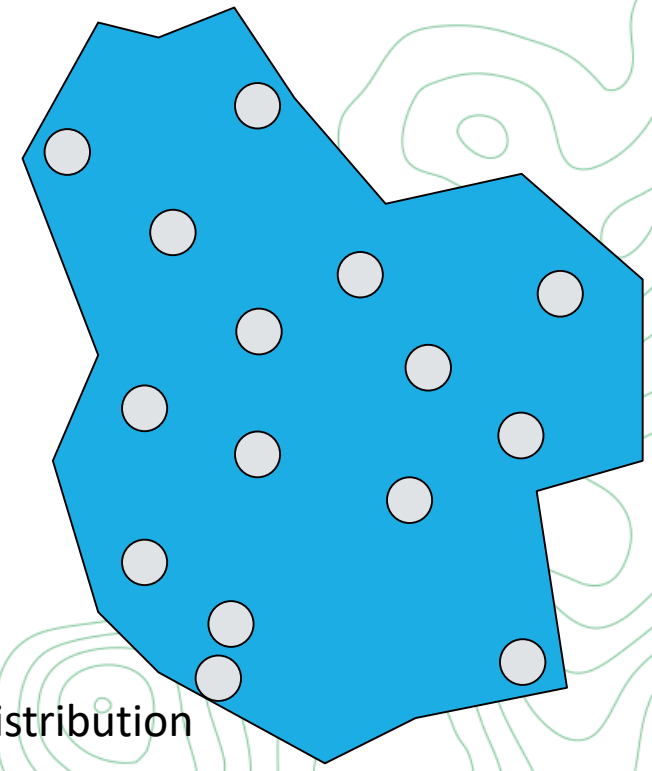


Plots distribution

- Systematic or random
  - Determine location on GIS before inventory
  - Or choose on the field if specific characteristics are targeted.

Systematic distribution

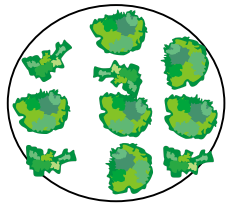


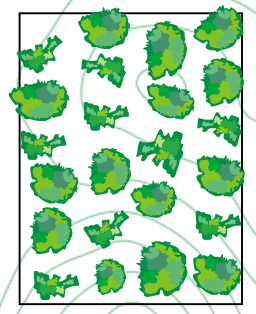


Random distribution

Type of plot

- Size
  - Between 100 and 1000 m²
  - For biodiversity : to be determined with area/nb of species curb
  - For biomass : area/biomass per ha curb
  - Try to have at least 20 trees in average
- Shape of the plot
  - Circle or square?
    - Square adapted for forest plantation (trees planted in lines)
    - Circle : easy to implement on the field and easy to locate (1 point at the center vs 4 points at each corner)





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Tools

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Tools

- To measure diameter

calliper
Pied à coulisse

Compass
Compas en C

Measuring tape for diameter
Ruban diamétrique

Tools

- To measure tree height

Compass and hypsometer
Boussole et hypsomètre Suunto

Vertex – electronic hypsometer
Hypsomètre Vertex Forestor

Laser hypsometer
Hypsomètre Ace Laser

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Good measuring practices

- Diameter – most important variable
  - Can be the only variable
  - Convention is Diameter at Breast Height (DBH) = 1.3 m
    - Use a wood stick of the appropriate length

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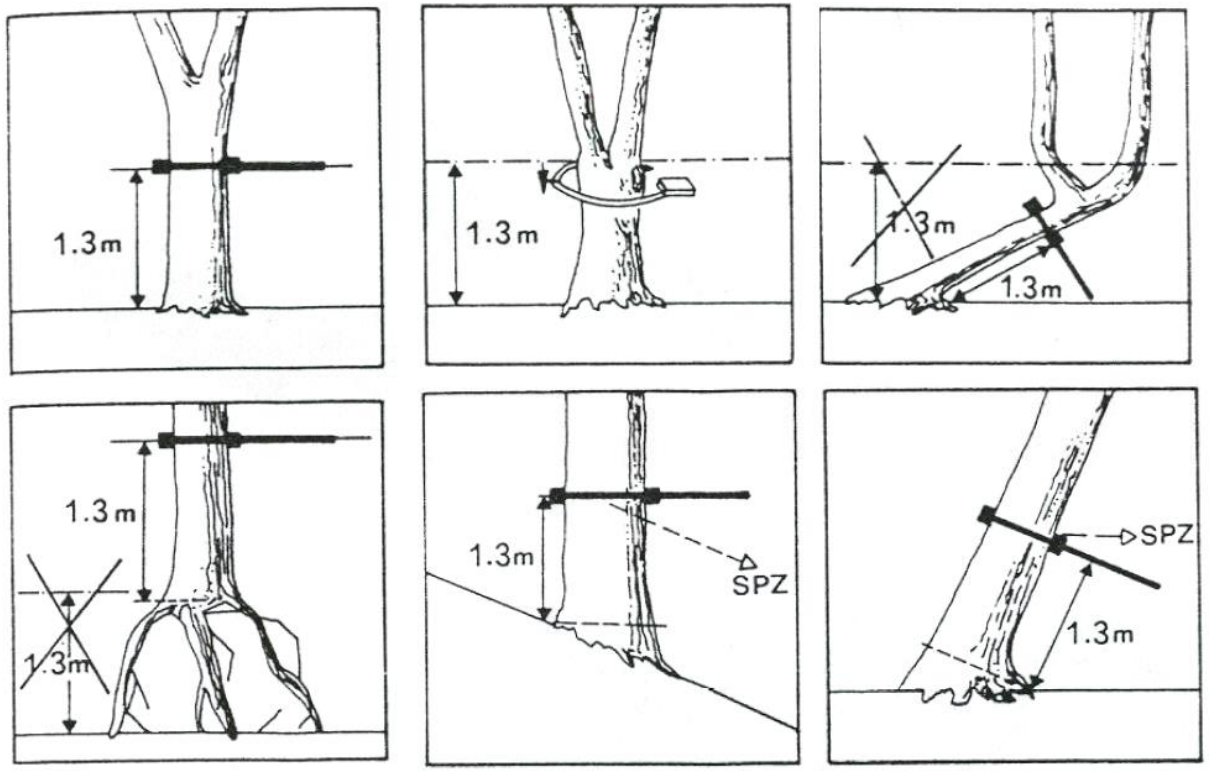
Good measuring practices

- Diameter – most important variable
  - Can be the only variable
  - Convention is Diameter at Breast Height (DBH) = 1,3 m
    - Use a wood stick of the appropriate length
  - Account for deformation of trunks



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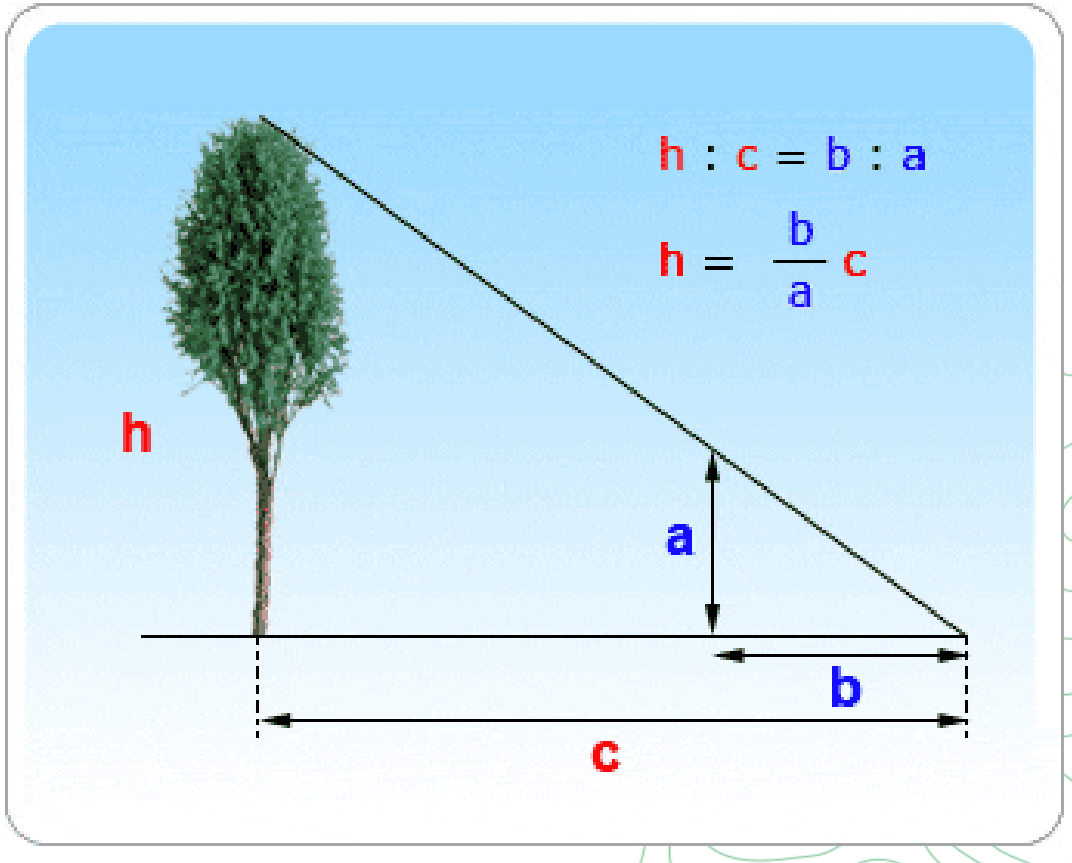
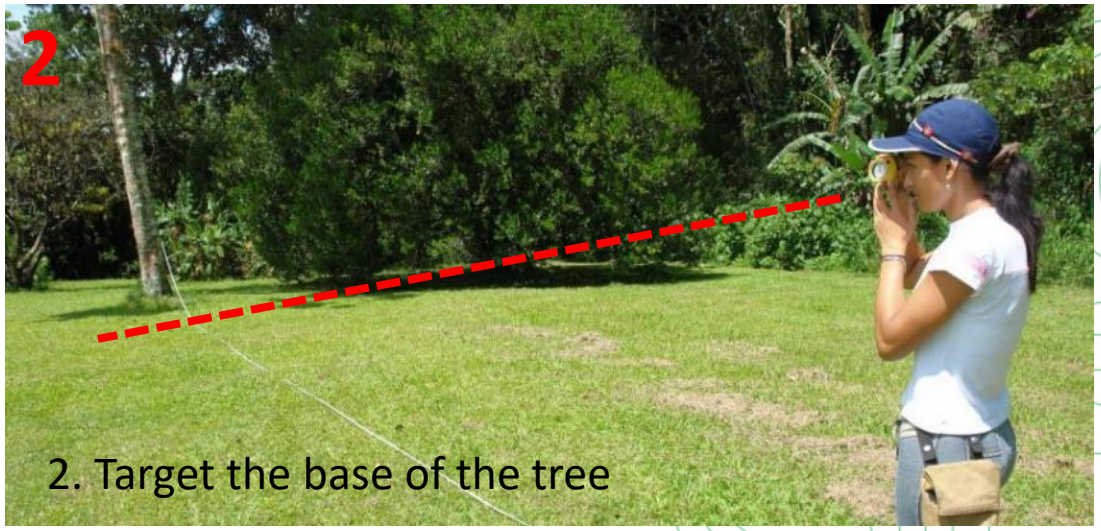
Good measuring practices

- Height
  - It depends on the measuring tool
    - Tools are based on the measurement of an angle
  - At least 2 steps :
    - Measurement of the distance to the tree
    - Measurement of the height

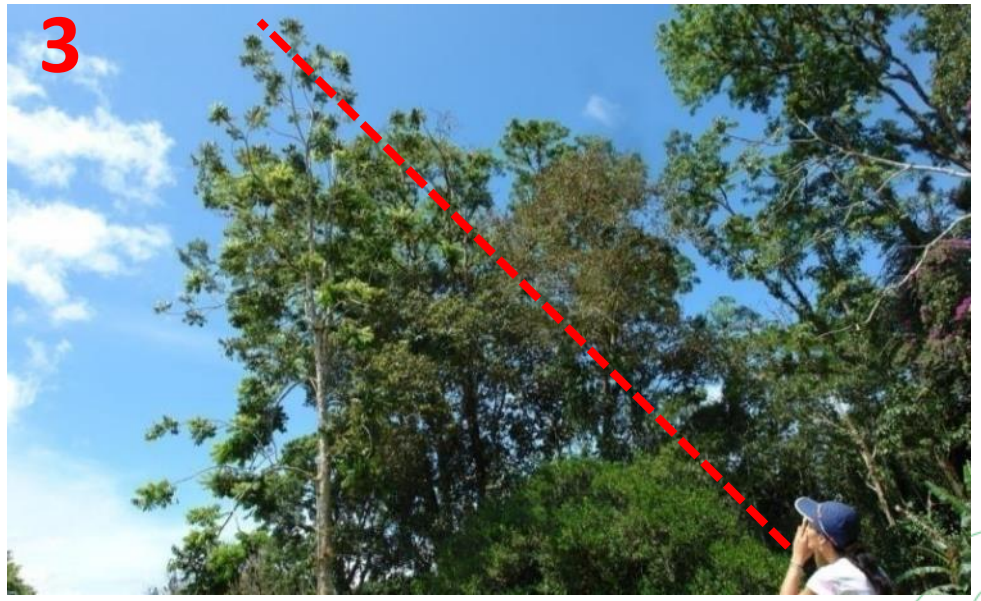


Mesurement of tree height

1. Standard distance



2. Target the base of the tree



3. Target the top of the crown

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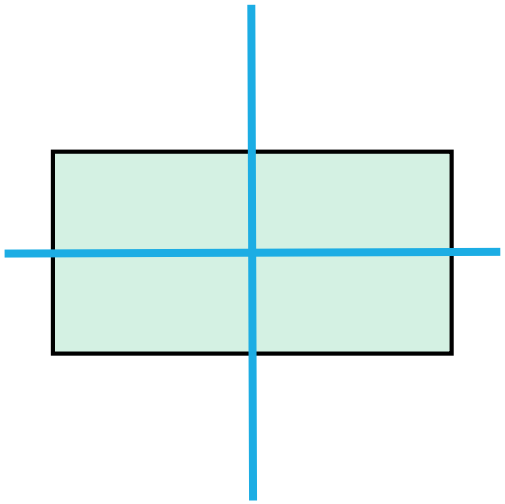
Measurement of dead wood

- On a transect
- Use measuring tape
- Usually, not a significant pool



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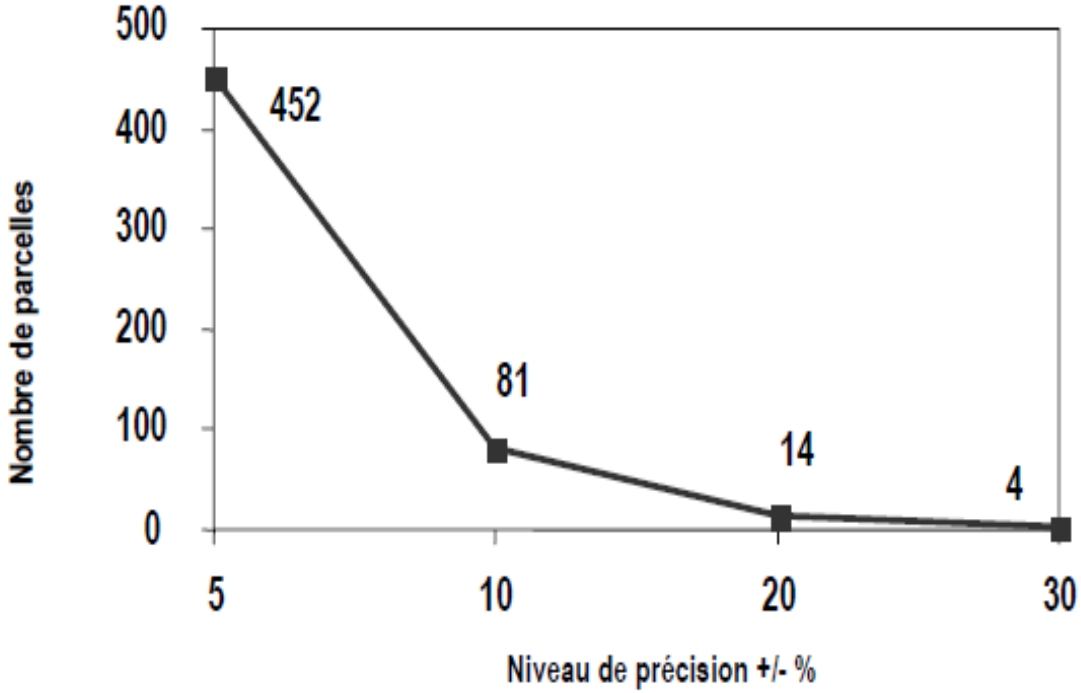
Let’s go to test on the field

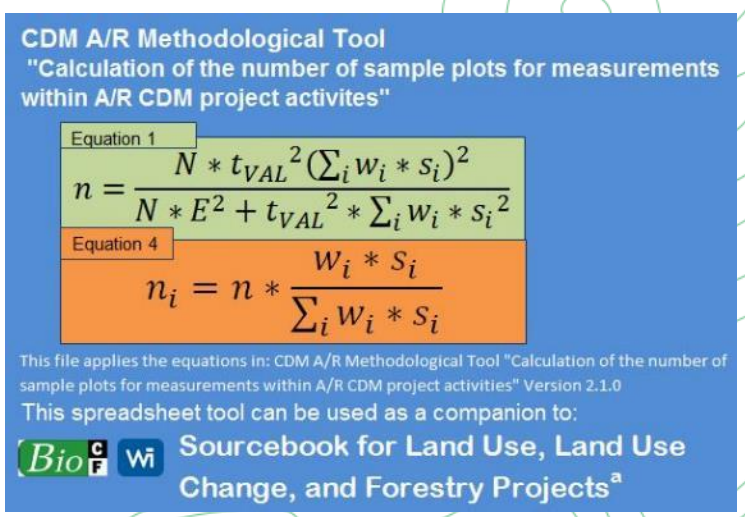
Determine the number of plots

- Depends on
  - The level of accuracy
  - The variability of carbon stocks (or other indicator) between plots
- A number of plots per strata to be determined



Determine the number of plots

- Easy way to determine the number of plots: using the tool developed by winrock
  - Downlaod at: https://www.winrock.org/document/winrock-sample-plot-calculator-spreadsheet-tool/
  - Need to have done some plots to start using the tool
- The tool calculates the number of plots needed per strata according to:
  - The level of error required
  - The area of the stratum
  - The mean carbon stock (it requires some inventoried plots)
  - The standard deviation (it requires some inventoried plots)
  - The size of the plot



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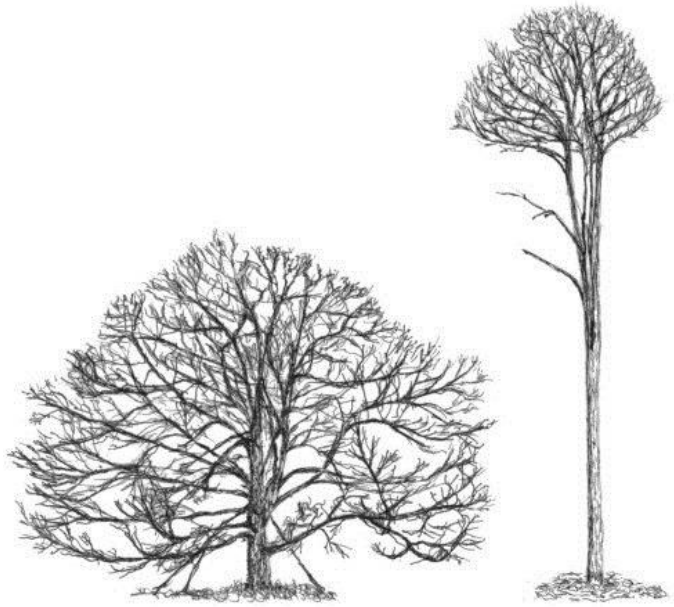
Calculation of carbon stocks

- Use an allometric equation
  - Relation between aboveground biomass (AGB) and diameter, tree density and sometimes tree height
    - AGB = f(DBH, ρ, h)



Calculation of carbon stocks

- Use an allometric equation
  - Relation between aboveground biomass (AGB) and diameter, tree density and sometimes tree height
    - AGB = f(DBH, ρ, h)
  - The most used : Chave equation
  - It can exist local or national equations
    - To be preferred if they exist

Chave, 2005
- With or without H
- For dry and wet forests and mangroves

Oecologia (2005) 145: 87–99
DOI 10.1007/s00442-005-0100-x

ECOSYSTEM ECOLOGY

J. Chave · C. Andalo · S. Brown · M. A. Cairns
J. Q. Chambers · D. Eamus · H. Fölster · F. Fromard
N. Higuchi · T. Kira · J.-P. Lescure · B. W. Nelson
H. Ogawa · H. Puig · B. Riéra · T. Yamakura

Tree allometry and improved estimation of carbon stocks and balance in tropical forests

Wet forest stands:

$$\langle AGB \rangle_{est} = \exp\left(-2.557 + 0.940 \times \ln\left(\rho D^2 H\right)\right)$$
$$\equiv 0.0776 \times \left(\rho D^2 H\right)^{0.940}$$

$$\langle AGB \rangle_{est} = \rho \times \exp(-1.239 + 1.980\ln(D) + 0.207(\ln(D))^2 - 0.0281(\ln(D))^3)$$

Calculation of carbon stocks

- Use an allometric equation
  - Relation between aboveground biomass (AGB) and diameter, tree density and sometimes tree height
    - AGB = f(DBH, ρ, h)
  - The most used : Chave equation
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Chave, 2015
- With or without H
- Pantropical

Global Change Biology (2015) 20, 3177–3190, doi: 10.1111/gcb.12629

Improved allometric models to estimate the aboveground biomass of tropical trees

JÉRÔME CHAVE[1], MAXIME RÉJOU-MÉCHAIN[1], ALBERTO BÚRQUEZ[2], EMMANUEL CHIDUMAYO[3], MATTHEW S. COLGAN[4], WELINGTON B.C. DELITTI[5], ALVARO DUQUE[6], TRON EID[7], PHILIP M. FEARNSIDE[8], ROSA C. GOODMAN[9], MATIEU HENRY[10], ANGELINA MARTÍNEZ-YRÍZAR[2], WILSON A. MUGASHA[7], HELENE C. MULLER-LANDAU[11], MAURIZIO MENCUCCINI[12], BRUCE W. NELSON[8], ALFRED NGOMANDA[13], EULER M. NOGUEIRA[8], EDGAR ORTIZ-MALAVASSI[14], RAPHAËL PÉLISSIER[15], PIERRE PLOTON[15], CASEY M. RYAN[12], JUAN G. SALDARRIAGA[16] and GHISLAIN VIEILLEDENT[17]

When we regressed tree AGB (kg) against the product $\rho \times D^2 \times H$, we found the best-fit pantropical model to be:

$$AGB_{est} = 0.0673 \times (\rho D^2 H)^{0.976} \quad (\sigma = 0.357, AIC = 3130, df = 4002) \quad (4)$$

$$AGB_{est} = \exp[-1.803 - 0.976E + 0.976 \ln(\rho) + 2.673 \ln(D) - 0.0299[\ln(D)]^2] \quad (7)$$

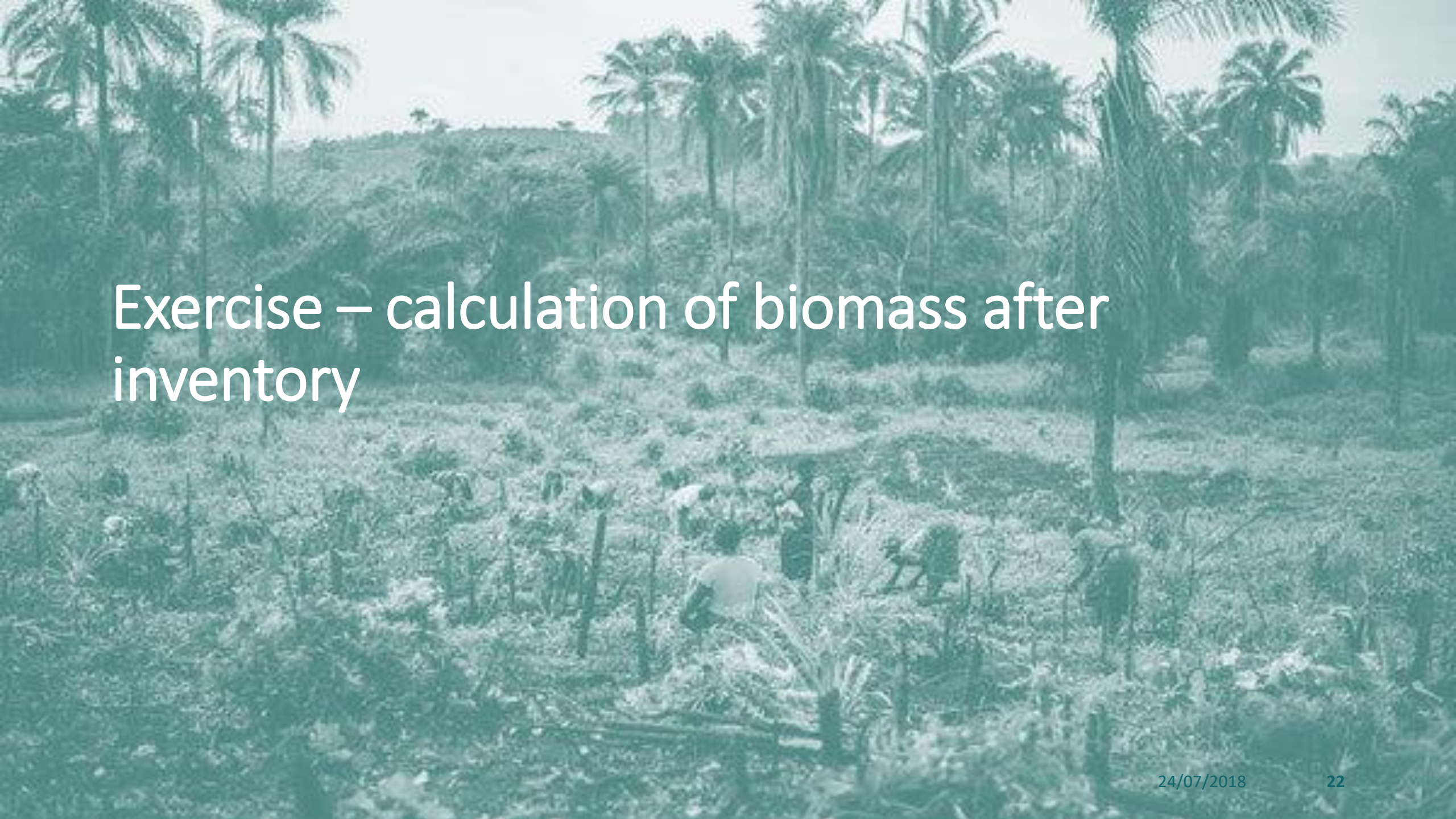
E depends on geographical position – can be downloaded from Chave website

Calculation of carbon stocks

- ρ available in Global Wood Density Database (freely available)
  - Depends on the tree species genus
- Use of a root-to-shoot ratio for calculation of BGB
  - Standard value : IPCC 2006 – Ch. 4 Forest
    - BGB = R.AGB

TABLE 4.4
RATIO OF BELOW-GROUND BIOMASS TO ABOVE-GROUND BIOMASS (R)

Domain	Ecological zone	Above-ground biomass	R [tonne root d.m. (tonne shoot d.m.)$^{-1}$]	References
Tropical	Tropical rainforest		0.37	Fittkau and Klinge, 1973
	Tropical moist deciduous forest	above-ground biomass <125 tonnes ha^{-1}	0.20 (0.09 - 0.25)	Mokany *et al.*, 2006
		above-ground biomass >125 tonnes ha^{-1}	0.24 (0.22 - 0.33)	Mokany *et al.*, 2006
	Tropical dry forest	above-ground biomass <20 tonnes ha^{-1}	0.56 (0.28 - 0.68)	Mokany *et al.*, 2006
		above-ground biomass >20 tonnes ha^{-1}	0.28 (0.27 - 0.28)	Mokany *et al.*, 2006
	Tropical shrubland		0.40	Poupon, 1980
	Tropical mountain systems		0.27 (0.27 - 0.28)	Singh *et al.*, 1994



Exercise – calculation of biomass after inventory

Exercice – calculation of mean biomass of a forest strata

- Existing inventory
  - Data for DBH, species and H available and filled into an Excel file
  - Forest type : dry forest
- Calculate:
  - Mean AGB in tdm/ha among the forest
  - Calculate total carbon stocks (AGB + BGB) in tC/ha
  - Calculate emissions related to deforestation in tCO_2/ha

Thank you for your attention

Questions?

Marie Nourtier

R&D project officer

m.nourtier@nitidae.org

www.nitidae.org

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