

Forest ecosystems modelling

~~18~~ 24 and 25 February 2025

Topic: data for the development of forest models.

Objectives:

- Introduce (or revise) some forest inventory variables. Remember: to learn more on this topic, you can assist to the extra class that will take place 26 February 2025 from 9h-11h.
- Clarify what are tree level data versus stand level data
- Recognize Excel and R as tools for forest data analysis
- Forest data plotting and basic analysis in excel and R

1. Forest inventory plots – tree data from the 5th Portuguese National Forest Inventory, collected in pure forest plots with *Pinus pinaster*.

1.1. For each plot compute the number of trees per hectare and dominant height.

1.2. For the trees where total height was not measured, estimate this value using the following equation from Tomé et al. 2007¹.

$$h = h_{dom} \left(1 + \left(\beta_0 + \beta_1 \frac{N}{1000} \right) e^{\beta_2 h_{dom}} \right) \left(1 - e^{\beta_3 \frac{d}{h_{dom}}} \right)$$

β_0	β_1	β_2	β_3
0.0795	0.0211	0.0254	-1.1658

1.3. Make a plot of tree diameter at breast height and total height and discuss it.

1.4. In a different sheet plot the Tomé et al. 2007 function. Consider and plot, in the same graphic, the three following situations: ($N_1=100$; $h_{dom1}=5$), ($N_2=100$; $h_{dom2}=10$) and ($N_3=400$; $h_{dom3}=5$). Discuss the effect of N and h_{dom} in the total height of the tree. (Tip: “play with the function by considering different N and h_{dom} values”).

¹ Tome et al. 2007. Inventário florestal 2005-2006. Áreas, volumes e biomassas dos povoamentos florestais. Resultados Nacionais e por NUT's II e III. Publicações GIMREF - RT 5/2007. https://www.researchgate.net/publication/235004904_Inventario_florestal_2005-2006_Areas_volumes_e_biomassas_dos_povoamentos_florestais_Resultados_Nacionais_e_por_NUTs_II_e_III_Publicacoes_GIMREF_-_RT_52007

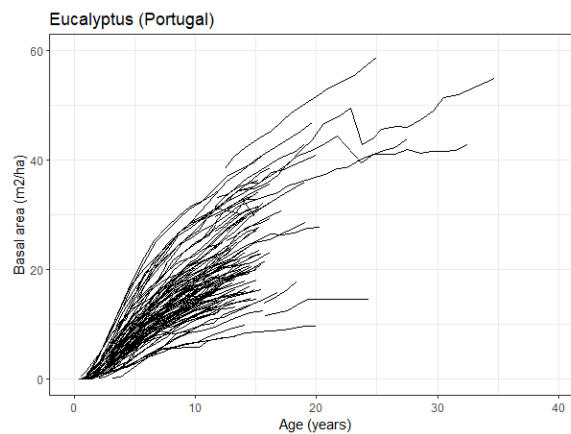
2. Permanent plots – effect of site index on growth and yield of eucalyptus stands. File “Exerc1PermanentPlots-Ec-S-data.xlsx” contains data from some permanent plots established in eucalyptus plantations in Portugal. All the stands were established at a 3x3 spacing.
 - 2.1. Illustrate, for each plot, the evolution of dominant height, basal area and volume as well as the mean and current annual increments in volume (plot the two increments in the same graphic).
 - 2.2. Find the site index (base age 10) for each one of the plots.
 - 2.3. Analyse the location of the maximum of the mean annual increment in volume and relate it with the site index
 - 2.4. Plot the evolution of the variables referred in 2.1) considering all the plots in the same graphic.

3. Permanent plots – effect of stand density at planting (spacing) on growth and yield of eucalyptus stands. File “Exerc2PermanentPlots-Ec-Npl-data.xls” contains data from the plots of one block of a spacing trial established in eucalyptus plantations in Portugal. Being a block from an experiment, all the plots have a similar site index. ²
 - 3.1. Illustrate, for each plot, the evolution of dominant height, basal area and volume as well as the mean and current annual increments in volume (plot the two increments in the same graphic)
 - 3.2. Find the site index (base age 10) for each one of the plots
 - 3.3. Analyze the location of the maximum of the mean annual increment in volume and relate it with the initial stand density (spacing)
 - 3.4. Illustrate, for each plot, the evolution of the biomass per tree component as well as the total biomass
 - 3.5. Plot the evolution of the variables referred in 3.1) considering all the plots in the same graphic

² Exercise 3 is very similar to Exercise 2. It should be used for the student’s independent work.

4. Permanent plots – dominant height evolution across consecutive measurements in cork oak plantations. File `data_hdom_dudom_Sb_003.csv` contains dominant height data for several plots and across several measurements.

4.1. Using R, make a plot similar to the one in this figure bellow.



- 4.2. The base age for cork oak plantations is considered to be 80 years of age. Discuss the data availability and needs for the assessment of site index for cork oak plantations.
- 4.3. Do a similar graphic to the one resulting from 4.1 but now for the evolution of dominant diameter across the stand age.