

Forest ecosystems modelling

24 March 2025

Topic: Growth functions.

Objectives:

- Recognize the main shape features of some of the most important growth functions in relation to the model parameters
- Practice the formulation of a family of difference equations
- Practice the formulation of a family of difference equations in the form of age independent

1 Analysis of the shape of the Lundqvist-Korf function for different values of the parameters

Using the EXCEL illustrate the shape of the Lundqvist-Korf function:

- a) Varying the asymptote A and keeping parameters k and m constant
Suggestion: $A=40, \dots, 100$; $k=3$; $m=0.7$
- b) Varying parameter k and keeping both the asymptote A and the parameter m constant
Suggestion: $A=90$; $k=1, \dots, 7$; $m=0.5$
- c) Varying parameter m and keeping the asymptote A and the parameter k both constant
Suggestion: $A=90$; $k=3$; $m=0.2, \dots, 0.8$
- d) Go to the link <http://home.isa.utl.pt/~joaopalma/modelos/fgfp/> and use the Forest Growth functions Playground to learn more about the role of each parameter on the shape of the growth functions.

2 Analysis of the shape of the Richards function for different values of the parameters

Using the EXCEL, illustrate the shape of the Richards function:

- a) Varying the asymptote A and keeping the parameters k and m constant
Suggestion: $A=40, \dots, 100$; $k=0.05$; $m=0.2$
- b) Varying parameter k and keeping both the asymptote A and the parameter m constant
Suggestion: $A=90$; $k=0.2, \dots, 0.08$; $m=0.2$
- c) Varying parameter m and keeping the asymptote A and the parameter k both constant
Suggestion: $A=90$; $k=0.05$; $m=-0.6, \dots, 0.6$

- d) Go to the link <http://home.isa.utl.pt/~joaopalma/modelos/fgfp/> and use the Forest Growth functions Playground to learn more about the role of each parameter on the shape of the growth functions.

3 Analysis of the shape of the Hossfeld IV function for different values of the parameters

Using the EXCEL, illustrate the shape of the Hossfeld IV function:

- a) Varying the asymptote A and keeping parameters c_1 and k constant
Suggestion: $A=40, \dots, 100$; $c_1=0.20$; $k=1.20$
- b) Varying parameter c_1 and keeping the asymptote A and parameter k constant
Suggestion: $A=90$; $c_1=0.10, \dots, 0.70$; $k=1.20$
- c) Varying parameter k and keeping the asymptote A and parameter c_1 constant
Suggestion: $A=90$; $c_1=0.40$; $k=0.90, \dots, 1.50$
- d) Go to the link <http://home.isa.utl.pt/~joaopalma/modelos/fgfp/> and use the Forest Growth functions Playground to learn more about the role of each parameter on the shape of the growth functions.

4 Formulate the Lundqvist-Korf growth function as difference equations

- a) Fit the Lundqvist-Korf growth function in its integral form. Use the data set provided for Practice 3 in sheet data_t.
- b) Repeat the fitting by testing stand variables (available in the data set) for significance in the model parameters. Compare the models using the root of mean square errors, R^2 -Adj, and residuals distribution. Build a table with these measurements for each alternative model you fit. Name the models in a clear form.
- c) Formulate the age independent difference equation form for the Lundqvist-Korf growth function.
- d) Fit the function obtained in c). Use the data set provided for Practice 3 in sheet data_t.
- e) Repeat the fitting carried out in d) by testing stand variables (available in the data set) for significance in the model parameters. Compare the models using the root of mean square errors, R^2 -Adj, and residuals distribution. Build a table with these measurements for each alternative model you fit. Name the models in a clear form.
- f) Formulate the difference equations model by solving the function for A (Lundqvist-Korf-A), K (Lundqvist-Korf-k) and n (Lundqvist-Korf-n).

- g) Fit one of the functions obtained in f) and test stand variables (available in the excel file in sheet data_pairs) for significance in the model parameters. Compare the models using the root of mean square errors, R²-Adj, and residuals distribution. Build a table with these measurements for each alternative model you fit. Name the models in a clear form.

5 Formulate the Richards growth function as difference equations

Repeat the exercise carried out in 4.

6 Formulate the Hossfeld growth function as difference equations

Repeat the exercise carried out in 4.

7. Formulate the monomolecular growth function as difference equations

Repeat the exercise carried out in 4.