The ModisPinaster model: an overview (2009-2014)

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Forest in Portugal

35% of the area is forest area
- 31% softwood species
- 69% hardwood species

Major species:
- **Eucalyptus** (812,000 ha; 26%)
- **Cork oak** (737,000 ha; 23%)
- **Maritime pine** (714,000 ha; 23%)

Outline

(1) Silvicultural models for maritime pine in Portugal

(2) ModisPinaster (2000-2009)

(3) ModisPinaster (2009-2014)
Silvicultural models for the species

Typical silvicultural model

The thinning interval is short to medium (5-10 years), corresponding to a top height growth of 2 to 3 m.

- **t0**
  - natural regeneration
  - or plantation/seeding

- **1st thinning**
  - 15 < t < 20

- **2nd thinning**
  - 25 < t < 30

- **t harvest = 35 yrs (minimum)**

Top height: 8 – 10m
Silvicultural models for the species

Thinnings, for different stand ages and site indexes, are usually from below (and mixed) commonly computed using the Wilson spacing factor:

\[ Fw = 100 N^{-0.5} hd^{-1} \]

Options include setting up a residual G or N or the use of the Stand density index, by Reineke:

\[ SDI = N(dg/25)^b \]

with b being 1.897 for maritime pine (Luis & Fonseca 2004)

Growth models available for the species

Santos Hall (1931) →
Stand Tables for even-aged stands of MNL

Hall & Martins (1986) →
Stand Tables for even-aged stands

Páscoa (1987/88) →
PBRAVO

More than 33 models or major model components (mainly regional)
In 2000 it was formally stated*, the need for a new model for maritime pine stands in North Portugal to help for forest management of the species.

Main desirable features of the new model G&Y:

- Easy of use for inventory update & thinning simulation
- Flexible description of the diameter classes
- Inclusion of a Mortality module

Available models:

- Site Index and Dominant Height Growth Curves (Marques, 1991)


The name: Model with diameter distribution for Pinus pinaster
Diameter distribution model – Johnson $S_B$ distribution

System of distributions proposed by Johnson (1949): $S_U$, $S_L$ e $S_a$

\[-\infty < \xi < \infty \quad \lambda > 0 \quad \delta > 0 \quad -\infty < \gamma < \infty\]

$x \sim S_B(\xi, \lambda, \delta, \gamma) \quad \Rightarrow \quad z = \gamma + \delta \ln \left( \frac{x - \xi}{\xi + \lambda - x} \right) \sim N(0,1)$
Procedure to obtain the parameters of the $S_B$ distribution

- **Parameter recovery method**
  - **percentil-moment**
  - **recovers lambda, delta and gamma parameters**


\[ \xi \quad d_{0.50} \quad \bar{d} \quad G \quad N \]

\[ 0.8d_{\min} \]
Mortality – wind and competition related

Wind damages (estimated to occur in the region 6 years each decade)

- tree leaning
- uprooting
- stem breakage

Mortality records (41 cases in the 121 permanent plots monitored)
Thinning

Trees to be removed from the diameter distribution were identified with a thinning algorithm (Alder, 1979).

The procedure assumes a probability of survival to cut proportional to a tree’s size,

\[ I(F) = Fc, \text{ with } c \text{ given by } \frac{N_t}{N_a}. \]

It depends on thinning weight

\[ N_{ja} = N_b L \left[ F(d_j)^{1/L} - F(d_{j-1})^{1/L} \right] \]

N – trees.ha\(^{-1}\)
b – before (white bars), t – thinned
a – after thinning (yellow bars)

ModisPinaster

Starting point (2000)

Design


Implementation (June, 2009)
ModisPinaster

C.P. Marques
(Scientific and professional mentor & Leader of the funding Projects)

M. Tomé
(PhD supervisor)

C. Meredieu
(the Promoter of the implementation into the Capsis platform, INRA)

F. de Coligny
(the Developer responsible for achieving it, INRA, AMAP)

Starting point (2000)
Design
Implementation (June, 2009)

Barcelona COST Action FP0603 Meeting, 15-16 January 2009
Why Capsis 4?

**Good reputation** of the supporting institutions (e.g. INRA)

**Secure platform** (confidence on perennity)

**Professional and technical support by the Developers**

**Easy to run** in different operative systems (Windows, MacOSX, Linux)

**Free** software

+ all the properties of using Java language  
  (easier than others, free, easier for distribution, stable)

**Use of existing extensions** ➔ model improvement

**Easy to share** the model with the forest managers

**Easy to do** simulations within the Capsis platform
Implementation

Integration of ModisPinaster in Capsis platform

François de Coligny
(Capsis Developer)

Training / Discussions (fc, cm)
Integration of the stand level modules
Integration of the distribution part
Submodels revision

COST
STSM FP0603 04967 (8-20 June 2009, at AMAP, Montpellier)
Formation: CAPSIS training

7-9 June 2009 9 of June: the 1st interface was built!
Results (first version – June 2009)

Minimal Input

Homogeneous stands, by default

To improve the initialization of stand variables

Merchantibility limits, set by the user

[Diagram of software interface showing stand characteristics and options for stand nature and volume merchantable calculations]
5 years projection
Stand table and Diameter Distribution
Mortality

Before and after
Thinning

Interactive procedure (low, high, mixed) by F. de Coligny or automatic procedure (Alder’s thinning algorithm), or both
Next steps

What was considered necessary to do in a short term?

- **Standardization of variables symbols** (and definitions) (compatible with programming languages)
- **Use of the model to find out for deficiencies (if any)**
- **Divulgation**
- **Feedback from the users**

Presentation to the potential users

Amendments/modifications to improve ModisPinaster
Use of the model and improvements

New available data and new ideas and suggestions

more accurate equations calculated from new field data, thinning with the Wilson factor or the Stand density index, better mortality assessment.
Thinning options

1. Wilson Spacing Factor
2. Number of trees
3. SDI %
4. Thinning diagram
   (By F. de Coligny)
   Cut trees by action on an interactive diameter distribution histogram
Technical Meeting and Training session
Management of maritime pine: use of the ModisPinaster simulation model

by Teresa Fidalgo Fonseca and François de Coligny


19 - 21 October 2011, Universidade de Trás-os-Montes e Alto Douro, Vila Real, Portugal
Universidade de Trás-os-Montes e Alto Douro, Vila Real, 19/10/2011, 14h30m, F2.18 (25 participants)
Presentation of the model
Selection of “case studies” for simulation purposes

Feedback from the users

Description of the model in:

Use of the model and improvements

**COST**

STSM FP0902 151012-023494  (15-23 October 2012, at AMAP, Montpellier)

Adaptation of ModisPinaster model within Capsis to provide estimates of wood energy. Several sub-models were adapted and new outputs about biomass, fuel and energy were added.

**Erasmus**

Program for formation  (21-28 May 2014, at AMAP, Montpellier)

Stocking management and several new outputs concerning crown height and crown bulk density were added.
“Automatic” integrated management procedures were incorporated.
Later on:

Spacing factor - Fw
Biomass, carbon and energy by diameter class and by tree component

Crown and canopy descriptors
What was the contribution of Capsis to ModisPinaster?

**Model improvement** (use of already available features and extensions)
- E.g. friendly interface
  - table and graphical extended outputs (biomass, energy, canopy variables,...)
  - new thinning algorithm options
- ...

**Easy to do** simulations within the Capsis platform
**Easy to share** the model with the forest managers
**No cost for the users**
What was the contribution of ModisPinaster to Capsis?

**Jonhson $S_B$ distribution model**
LM code now available in a Capsis library

**New thinning algorithm options**
trees cut according to trees size and to thinning weight

**Automatic management options (Wilson Factor /SDI values)**

**Mortality module**
mortality related to wind
mortality related to density
ModisPinaster

2000
2004

....

2009
2014

A never ending story?
What’s next?

- Coordinate the simulation outputs with optimization routines in order to compare results of management options subject to restrictions, for a set of stands.

- Incorporate models to allow the initialization of state variables (e.g. stand basal area) from number of trees and stand age.

- Test the use of the model for short term rotation (...data collection needed, new models required...
Thank you for your attention

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_In memoriam_ to the co-author of the model, Bernard Parresol (dec. 29/09/2013), a great friend.