SIMANFOR

Models

Aitor Vázquez Veloso

16/04/23

Instituto Universitario de Investigación iuFOR GESTIÓN FORESTAL SOSTENIBLE

introduction

web

publications

SIMANFOR

inventories

scenarios

models

results

- Model typologies on SIMANFOR
- Names of the models
- Model's content
- Use recommendations

Model typologies on SIMANFOR

Model typologies on SIMANFOR

SIMANFOR is a tool that allows the use of forest models efficiently and easily.
To define the forest models terms we can use resources like the Glosario Técnico Forestal de la SECF, where they define the following terms:

model: an abstract representation of objects and events from the real world to characterize a phenomenon or to simulate processes and predict their results, i.e., quantitative models that use as relationships mathematical equations.

stand model: stand dynamics models

stand dynamics models: a simulation model for forest stands that predicts the evolution of stand variables (growth, mortality, regeneration and changes related to the stand). Note: model inputs used to be stand variables like species, density, age, site quality and silvicultural treatments; the outputs use to be tables with the density and volumes classified by diametric classes and wood products for a reference age

To the previous ones should be added:

- individual tree model

Forest stand simulation model that predicts the evolution of the variables of each tree that makes up the stand and the stand itself (compared to stand models, these use and calculate larger tree variables)

On the other hand, these individual tree models can use the position of the tree in the plot for their calculations, including the calculation of variables such as competition. In this case, we are speaking about distance-dependent models, while distance-independent models are those that do not include the position of the tree in the plot for their calculations.

It is also important to note whether the models were developed for a single species (pure) or for a certain species mixture (mixed).

Finally, it is also necessary to make a point regarding the models' ability to project calculations over time. We talk about dynamic models when they are able to predict tree or stand growth and therefore project their state at a future point in time; static models do not include growth calculations, and therefore only allow calculations to be made for a known point in time.

Knowing these concepts, you will now be able to better understand the models included in SIMANFOR.

Model typologies on SIMANFOR

SIMANFOR can use different model typologies:

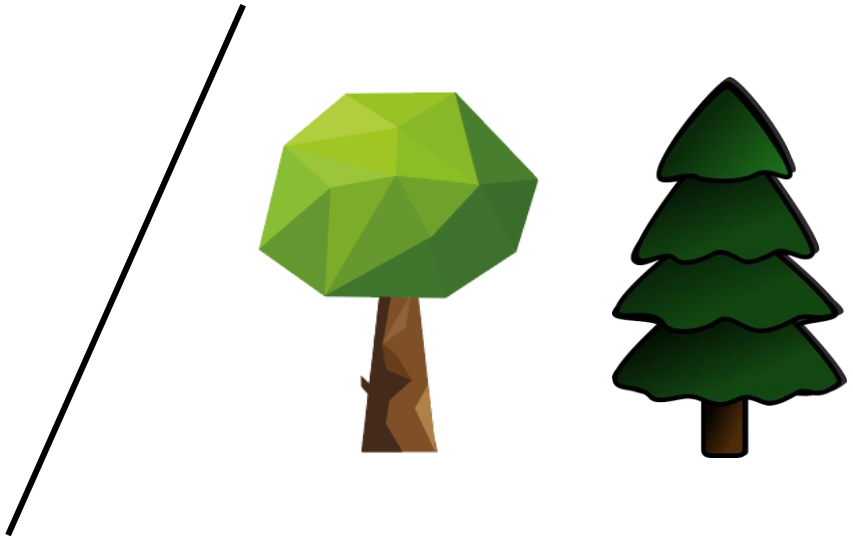
- Distance-independent single-tree dynamic models for pure stands
- Distance-independent single-tree dynamic models for mixed stands
- Distance-independent single-tree static models for pure stands
- Distance-independent single-tree static models for mixed stands
- Dynamic models for pure stands
- Static models for pure stands

Moreover, SIMANFOR includes 3 different harvest typologies:

- Systematic harvest model
- By below harvest model
- By above harvest model

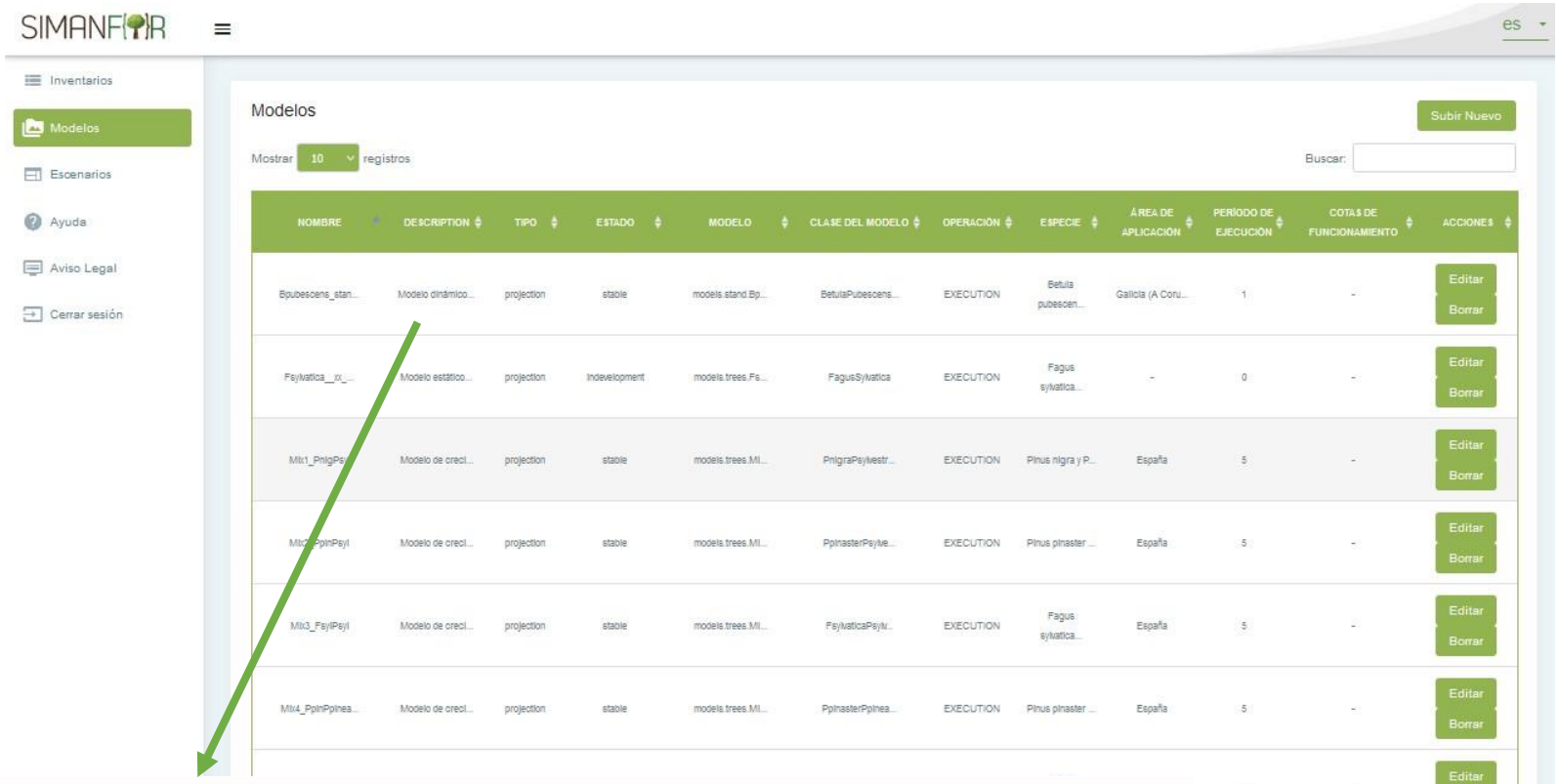
Model typologies on SIMANFOR

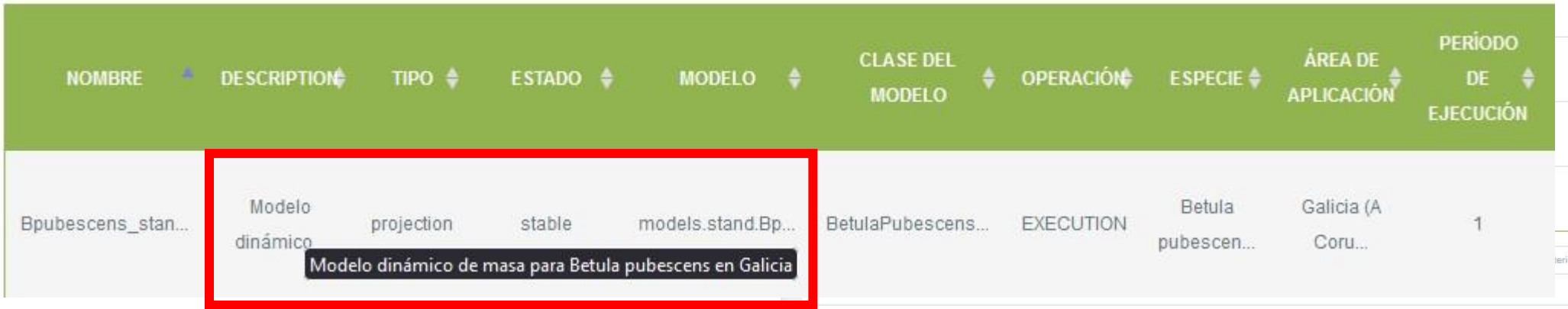
SIMANFOR uses the same model (structure and calculation workflow) with different parametrizations depending on the locations and species we want to work with, as their behaviour is not the same.



Model typologies on SIMANFOR

In the "Models" section of the SIMANFOR webpage, you can check all the models available at the moment.
To see the model type, you should look at the second column (DESCRIPTION) and put your mouse over the content to see it in its entirety





Names of the models

Names of the models

The model's names available on SIMANFOR use a common criteria to be named:

- Species name
- Location where it was fitted
- Version
- *To remark stand or mix models (the rest are individual-tree pure models)

On the right, you can see some examples.

Ppinaster_me__sim__v02

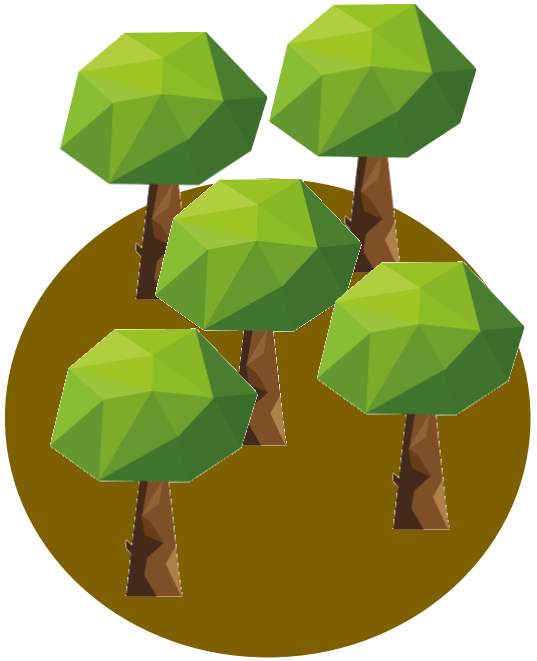
Bpubescens_stand__gal__v01

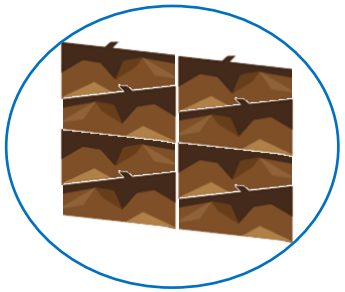
PnigraPsylvestris_mix__ es__v01

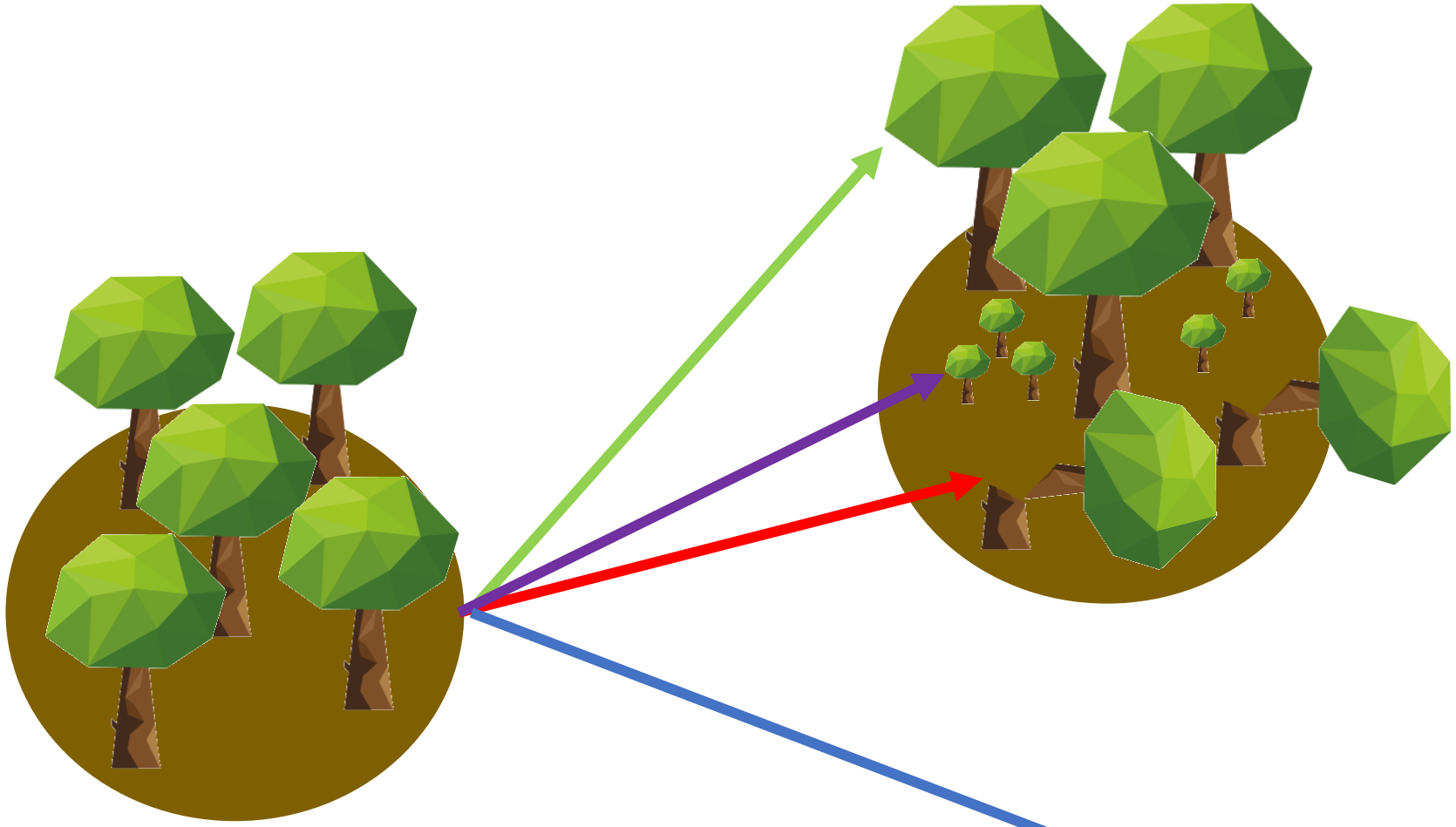
Model's content

Model's content

The content of forestry models varies from one model to another depending on the information (equations for calculation) available for each parametrization (species and location).
However, each model has a description sheet associated with it, which you can find here by searching for the model name.
All models include calculations of static variables (for a certain moment in time), including crown variables, volume over/under bark, biomass for different tree sections, wood products classification according to their industry destination, and even non-timber forest products such as pine nuts or mushrooms.
In addition to this, the dynamic models include 3 fundamental calculations (next page).







PROJECTIONS

Survival/mortality

Growth

Ingrowth

HARVEST

PROJECTIONS

The equations that allow the projections to be made are (following this order):

- Survival/mortality

Sub-model that determines whether a tree is still alive or not at the time to be projected (acts on its expansion factor; that sub-model may not be available)

- Growth

Sub-model that determines, after estimating mortality, the growth of every single tree (mandatory for dynamic models)

- Ingrowth

Sub-model the estimates, after mortality and growth estimations, how many trees will be incorporated into the stand (that sub-model may not be available)

HARVESTS

Each stand model has its harvest sub-models (always systematic, since there is no tree data), while for individual tree models, the harvests are applied on the expansion actor and are classified as follows:

- Harvest type (choose the type of trees to cut)
  - Systematic: it cuts the same proportion of each tree
  - By above: it cuts the bigger tres of the plot
  - By below: it cuts the smaller tres of the plot

- Harvest criteria (variable to which the harvest intensity is applied)
  - Number of trees: harvest intensity applied to the plot density
  - Basal area: harvest intensity applied to the plot basal area
  - Volume: harvest intensity applied to the plot volume

- Harvest intensity (%)

The harvest intensity fix the percentage of trees to extract

Model's content

That's the contents of each model, but… how are they included in the simulator?

Nice question!

Although it is beyond the scope of this manual, I would like to give a brief overview of this issue. SIMANFOR consists of a large set of files, most of them programmed in Python language, interconnected and with different functionalities. Within this ecosystem of code are the models that we can see on the website. In them, each calculation is composed of one or several equations extracted from scientific articles and programmed in Python language, which will use the data from your inventory to make calculations and, in turn, provide this information to the following equations of the model, EXCITING!

All the equations that make up each model are listed in their data sheets. If you want to create, modify or design your own model, just contact us.

$$d_{i5} = e^{-0,37110+0,2525*\ln(d*10)+0,7090*\ln(\frac{cr+0,2}{1,2})+0,9087*\ln SI-0,1545*\sqrt{G}-0,0004*\frac{bal^2}{\ln d*10}}/10$$

$$h_{i5} = e^{3,1222-0,4939*\ln(d_{i5}*10)+1,3763*\ln SI-0,0061*bal+0,1876*\ln(cr)}/100$$

```python
def growth(self, time: int, plot: Plot, old_tree: Tree, new_tree: Tree):
    """
    Tree growth function.
    A function that updates dbh and h by using growth equations, and also update age, g, and v to the new situation.
    Source:
        Doc.: Lizarralde I (2008). Dinámica de rodales y competencia en las masas de pino silvestre (Pinus sylvestris L.)
        y pino negral (Pinus pinaster Ait.) de los Sistemas Central e Ibérico Meridional. Tesis Doctoral. 230 pp
        Ref.: Lizarralde 2008
    """

    try:  # errors inside that construction will be announced

        if old_tree.specie == Model.specie_ifn_id:  # specie condition

            new_tree.sum_value('tree_age', time)

            if plot.si == 0:
                dbhg5: float = 0
            else:
                dbhg5: float = math.exp(-0.37110 + 0.2525 * math.log(old_tree.dbh * 10) + 0.7090 * math.log(
                    (old_tree.cr + 0.2) / 1.2) + 0.9087 * math.log(plot.si) - 0.1545 * math.sqrt(
                    plot.basal_area) - 0.0004 * (old_tree.bal * old_tree.bal / math.log(old_tree.dbh * 10)))
            new_tree.sum_value("dbh", dbhg5 / 10)


            if dbhg5 == 0:
                htg5: float = 0
            else:
                htg5: float = math.exp(3.1222 - 0.4939 * math.log(dbhg5 * 10) + 1.3763 * math.log(
                plot.si) - 0.0061 * old_tree.bal + 0.1876 * math.log(old_tree.cr))
            new_tree.sum_value("height", htg5 / 100)

            new_tree.add_value('basal_area', math.pi*(new_tree.dbh/2)**2)  # update basal area (cm2)

            self.vol(new_tree, plot)  # update volume variables (dm3)

    except Exception:
        self.catch_model_exception()
```

Use recommendations

Use recommendations

Before selecting the model that better fits with your study case you should check their model sheet, where different information about the model and its content is summarized, and some useful recommendations are included to guarantee that the model will run smoothly:

- Name of the model
- Species, code and application área
- Model type
- Variables needed on the initial inventory
- Recommended execution time

SIMANFOR

Modelo para *Pinus pinaster mesogeensis*
Sistema Ibérico Meridional (España)

Modelo

Ppinaster_mc_sim_v02

Descripción del modelo

- Especie: *Pinus pinaster* Ait. subsp. *mesogeensis*
- Código del Inventario Forestal Nacional Español (IFN): 26
- Área geográfica: Sistema Ibérico Meridional
- Área geográfica (administrativa): Soria, Guadalajara, Cuenca y Teruel

Tipo de modelo

- Categoría: crecimiento
- Nivel del modelo: modelo de árbol individual independiente de la distancia
- Forma fundamental: monte alto
- Forma principal: regular
- Composición: pura
- Origen: natural y seminatural

Requisitos y recomendaciones de uso

- Requisitos del inventario inicial: edad, altura dominante y área basimétrica de parcela; expan y dbh de árboles
- Ámbito geográfico: Sistema Ibérico Meridional, zonas limítrofes y lugares de características similares (asumiendo ciertas diferencias)
- Tipo de masa: masas puras, resinadas o no
- Tiempo de ejecución recomendado: ejecuciones de 5 años (ecuaciones de supervivencia, crecimiento y masa incorporada desarrolladas bajo este criterio)
- Índice de Sitio calculado para una edad de referencia de 80 años

Figure 1: *Pinus pinaster*

Figure 2: Detalles de *Pinus pinaster*

Figure 3: Regiones de procedencia de *Pinus pinaster* en España

1

Do you want more?

introduction

web

publications

inventories

scenarios

models

results

simanfor.data@forest.uva.es