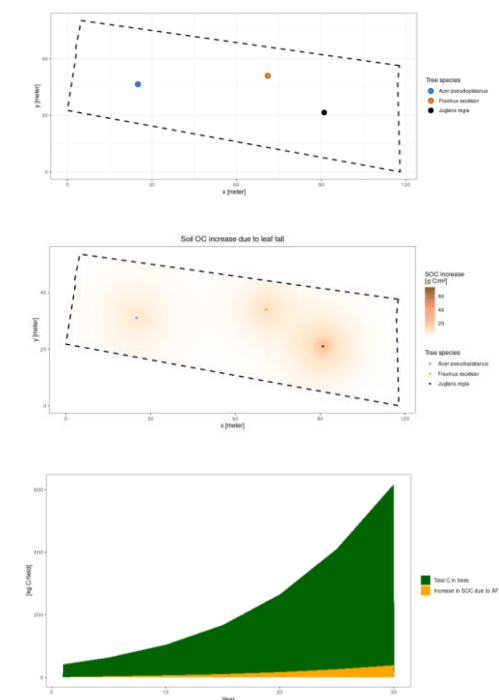


MANUAL

CARAT

CARbon Agroforestry Tool



Cite as:

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Practical manual of the CARAT tool

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I – Installation (for use on the device, with Rstudio)

A\ Download the tool

1. **Download** the folder of the tool.
2. Right-click on the folder to select *Extract All*, and then follow the instructions.

Wherever you put the files, keep them all together, arranged in the same way, so that the tool can work.

B\ Install R

First, install R (the programming language of the tool) by following the instructions below.

1. To ensure that the R scripts running the tool will work, download preferably **R.4.1.2** or **R.4.1.3*** with the given links.

**! The tool does not work yet with the R.4.3 version, because of a known problem of conflicting packages.*

→ If your operating system is **Windows** :

- R.4.1.2 : <https://cran.r-project.org/bin/windows/base/old/4.1.2/> > Click on “R-4.1.2-win.exe” to download the software.
- R.4.1.3 : <https://cran.r-project.org/bin/windows/base/old/4.1.3/> > Click on “R-4.1.3-win.exe” to download the software.

→ If you are using **macOS**, download here a version **older than R.4.3** : <https://cran.rstudio.com/> .

→ For a **Linux** system, follow this link to download R.4.1 : <https://cran.r-project.org/bin/linux> .

2. Once the file of the software is downloaded, click on it to execute the file and install the software.

C\ Install Rstudio

1. Download Rstudio (a developing software to use more easily the language R) by following this link : <https://posit.co/download/rstudio-desktop/> .

Pay attention to download the requested version, depending on your operating system.

2. Install the software by clicking on the downloaded file.

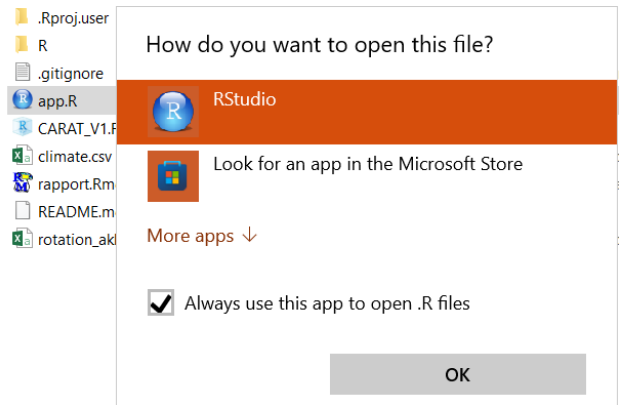
II – Use

A\ Opening with Rstudio

1. Opening

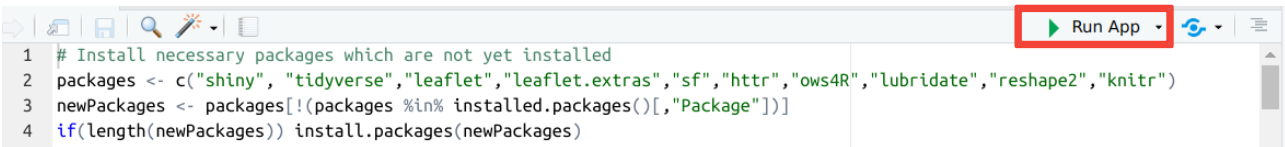
- **First use** : Right-click on the file “app.R” to open it with Rstudio, & select the option “*Always use this app to open .R files*”

→ **Following uses** : Double-click on the same file, and it should be opened automatically with the right software (Rstudio).

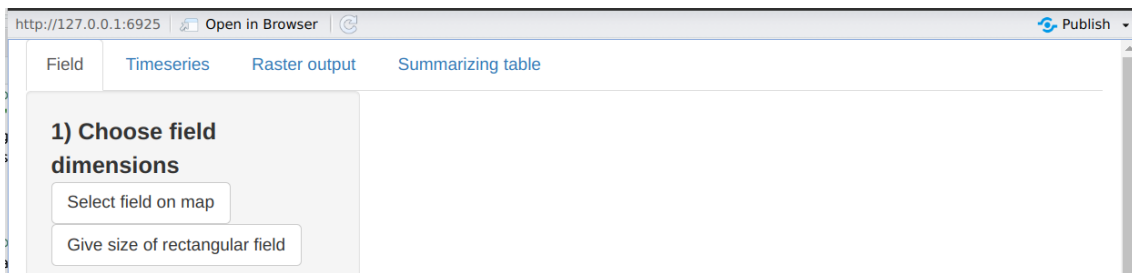


2. Running

- Click on the “*Run App*” button, just above the script :



→ This should open the CARAT tool on its first tab, titled “Field” :

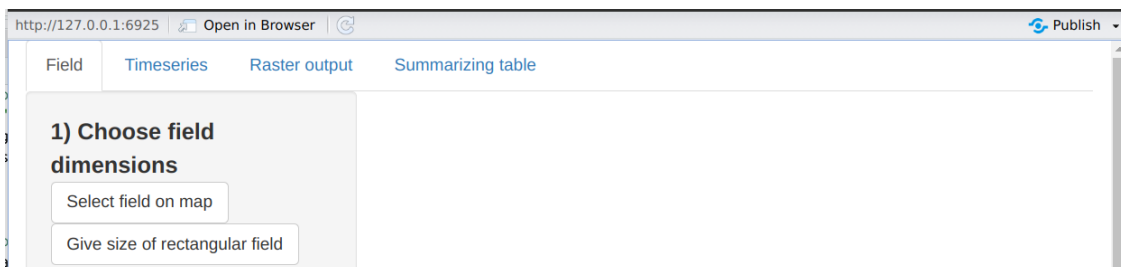


B\ Opening with the internet link

Simply click on this link : https://shiny.ilvo.be/PLANT/CARAT_v2/

Open the link is sufficient to run the tool.

→ So the CARAT tool should automatically open on its first tab, titled “Field” :



C\ Once open, using

1. Configuration of the field

a) Enter the dimension of your field. You have 2 options, as explained below.

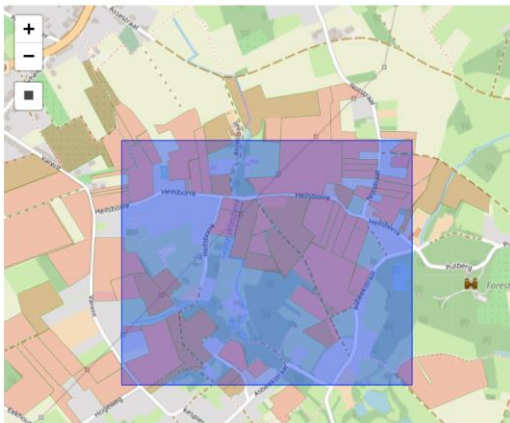
1st option > Select your field on a map, with the “*Select field on map*” button. It will open this window :

Select the area of interest on the map

- Zoom in or zoom out on the map thanks to the “+” and “-” buttons respectively.

- Move the displayed part of the map by grasping it with your computer mouse.

- 1) Select an area on the map to load fields in the area
- 2) Click on the field that you wish to use in the simulations



- To see all the registered fields of a selected area, click on the *rectangle* button, then click on the map and drag to draw a rectangle on it.

- Select your field and confirm with the “*Confirm selection*” button :



Confirm selection Cancel

This action will make your field to be drawn on the grid of the tool, as shown below.

1) Choose field dimensions

Select field on map

Give size of rectangular field

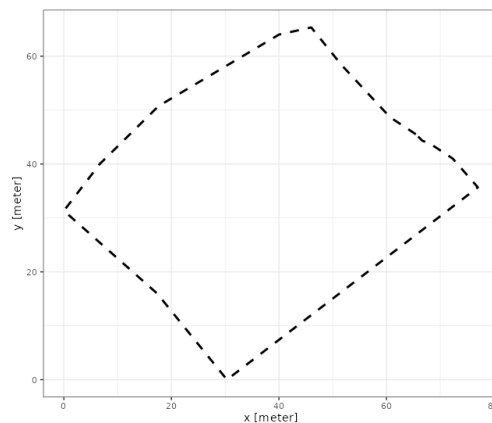
2) Select tree species

Acer pseudoplatanus

3) Place trees by clicking or creating a grid

Click in the plot area to place trees of this species, or specify spacing between the trees when planted in a grid

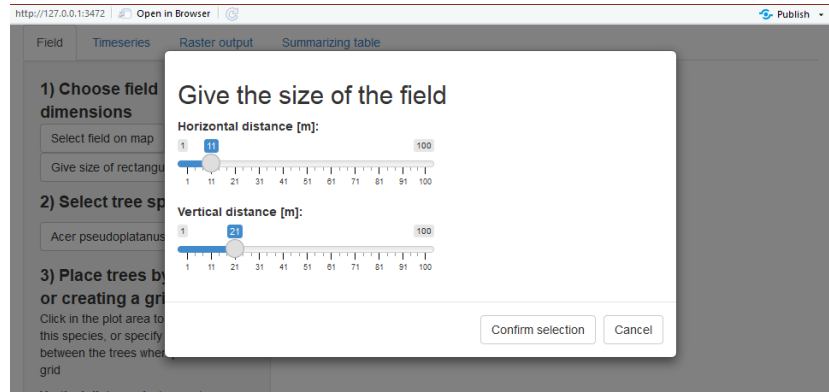
Vertical distance between trees



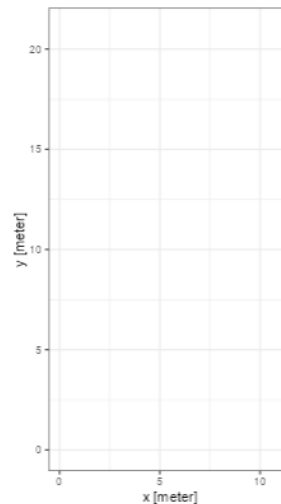
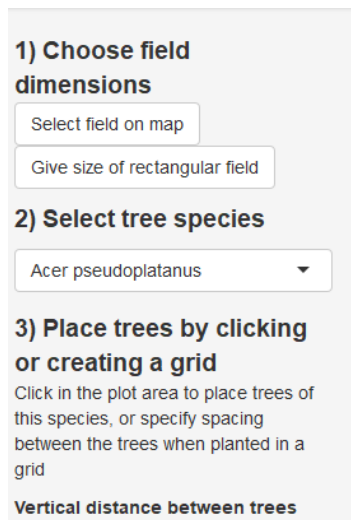
2nd option > Directly give the measures of your field, with the “*Give size of rectangular field*” button.

It will open this window :

When you have set up the dimension of the field for the estimation, confirm with the “*Confirm selection*” button.



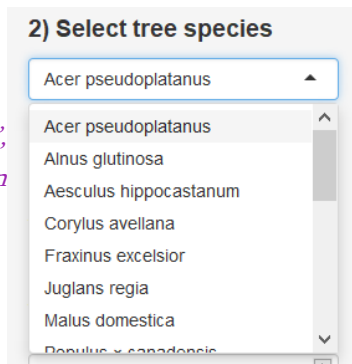
This action will set up the dimension of the tool's grid like the one of your field, as shown below.



b) Place the trees of each species on the field.

- Select the tree species among the drop-down list :

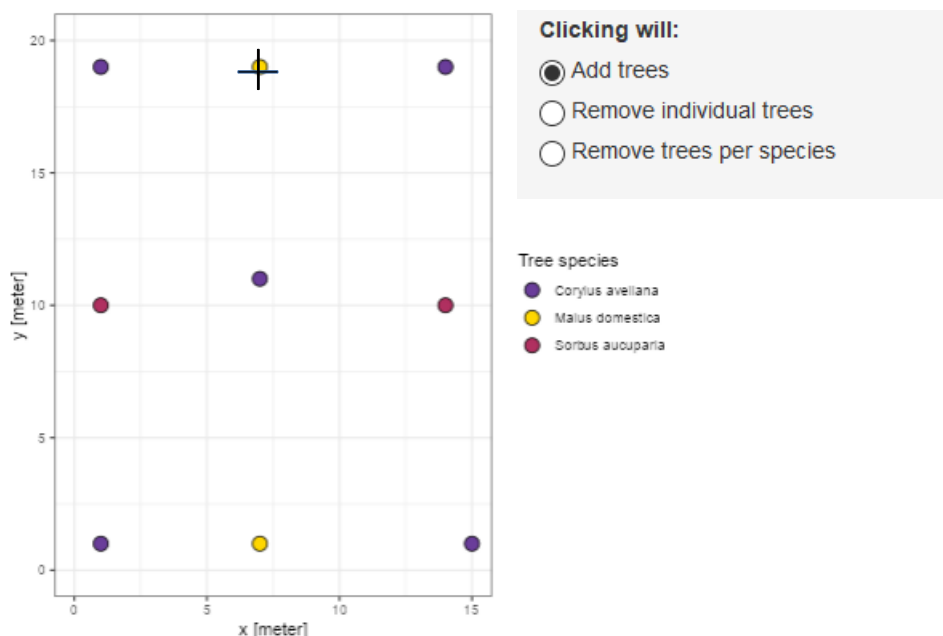
If you do not want to precise the tree species, you can choose the "Standard tree", whose models were designed to represent the general reactions of a tree in an agroforestry system.



- Then, you have 2 options, as explained below.

1st option > Click directly on the grid, where you want to put a tree.

Adding trees is the default action when clicking on the field grid, as you can see on the grey insert.



2nd option > Choose vertical and horizontal dimensions to create a regular grid of trees with the drop-down lists – as shown below, and then *Confirm*.

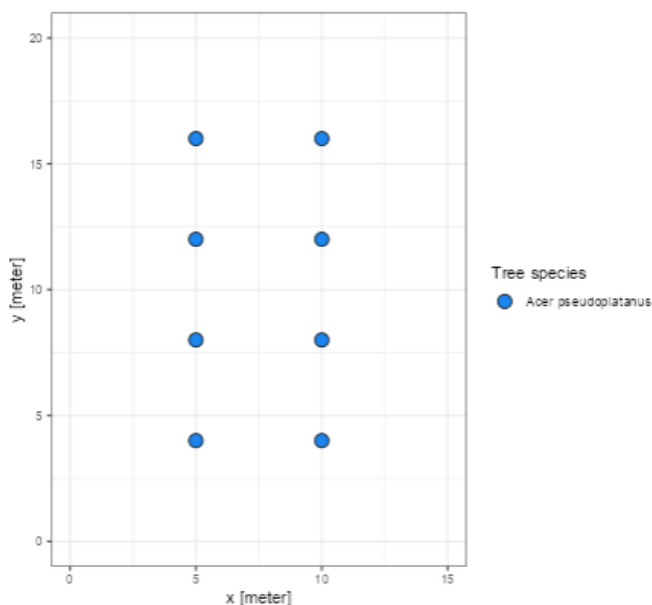
3) Place trees by clicking or creating a grid

Click in the plot area to place trees of this species, or specify spacing between the trees when planted in a grid

Vertical distance between trees [m]:
4

Horizontal distance between trees [m]:
5

Confirm

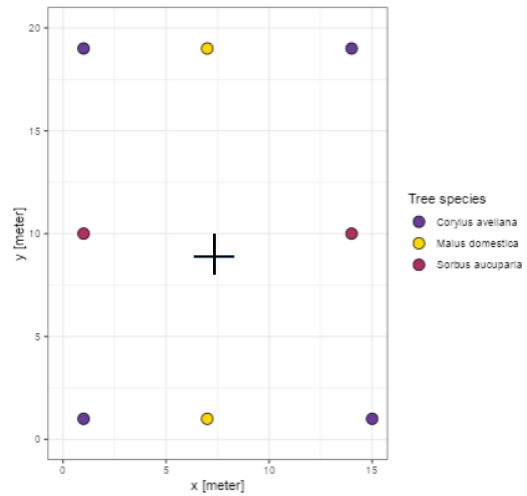


c) You can remove some trees, by changing the clicking action :

→ one by one (2nd option when clicking),

4) If necessary, remove trees
Clicking will:

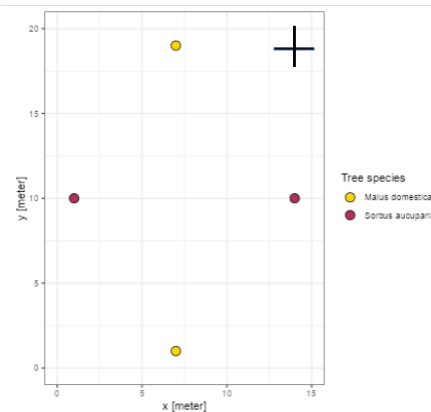
- Add trees
- Remove individual trees
- Remove trees per species



→ or all the trees of the selected species at once (3rd option).

4) If necessary, remove trees
Clicking will:

- Add trees
- Remove individual trees
- Remove trees per species



Pay attention that there is no confirmation button for these actions, and no backspace option either. Thus, if you click on a tree when the action is set up as “Remove (...)”, it will remove the requested tree(s).

→ When your simulated field is ready, you can open the 2nd tab of the tool, titled “*Timeseries*” :

| | | | |
|-------|------------|---------------|-------------------|
| Field | Timeseries | Raster output | Summarizing table |
|-------|------------|---------------|-------------------|

Clay percentage [%]:

2. Timeseries

a) As you can see in the picture below, the model has 5 parameters that you can adjust to your field characteristics. If you do not, they will be set to the default values, which are considered to represent the average of these parameters.

Field Timeseries Raster output Summarizing table

Clay percentage [%]:
0 5 100
0 10 20 30 40 50 60 70 80 90 100

Bulk density [g/cm³]:
1 1.4 2
1 1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8 1.9 2

Depth of plow layer [m]:
0.1 0.3 0.6
0.1 0.15 0.2 0.25 0.3 0.35 0.4 0.45 0.5 0.55 0.6

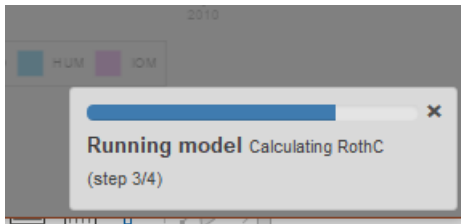
Initial SOC [%]:
0.1 1.05 5
0.1 0.6 1.1 1.6 2.1 2.6 3.1 3.6 4.1 4.6 5

Rotation
Arable land ▼
Run model

With the “*Rotation*” parameter, you can choose, among a drop-down list, between 2 agroforestry systems : Arable and Grassland.

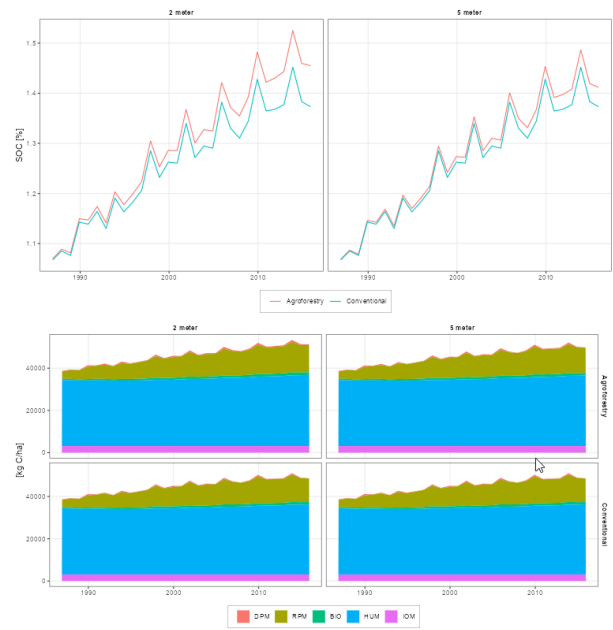
Rotation
Arable land ▲
Arable land
Grassland

b) When you have finished to set the parameters, click on the *“Run model”* button. After 4 running steps which can take several seconds...



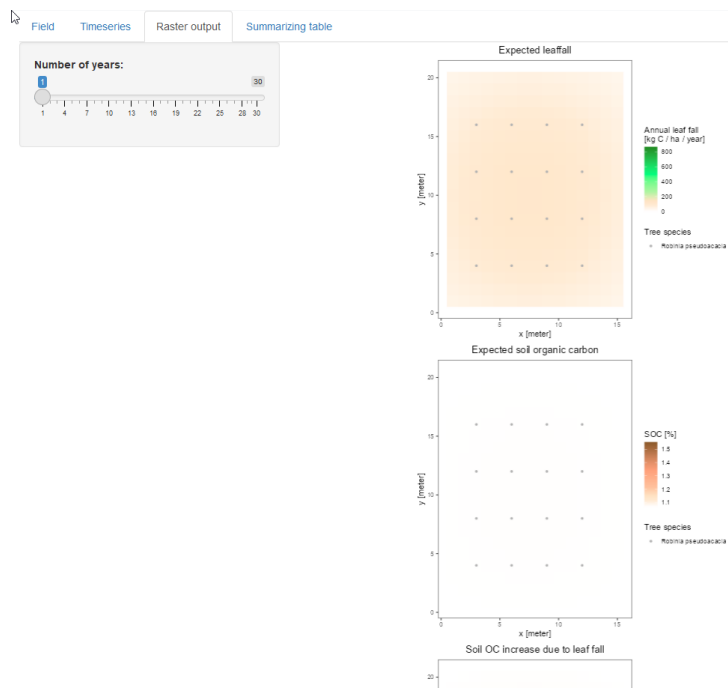
...you will see the first results, as shown opposite.

→ You can also open then the 3rd tab of the tool, titled *“Raster output”*.

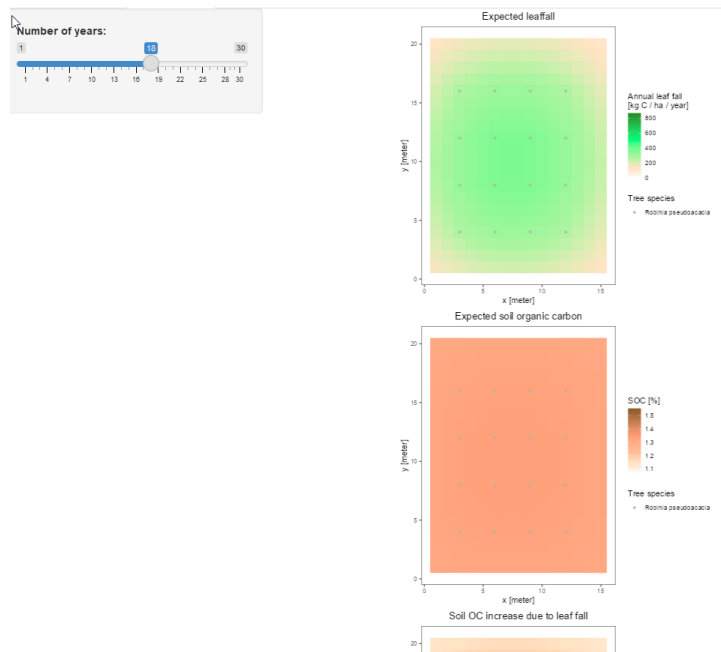


3. Raster output

This tab shows over the years, with a gradient of colours, the expected impact of tree growth on carbon sequestration in the field : leaf fall, soil organic carbon and the proportion of it which would be due to the leaf fall.

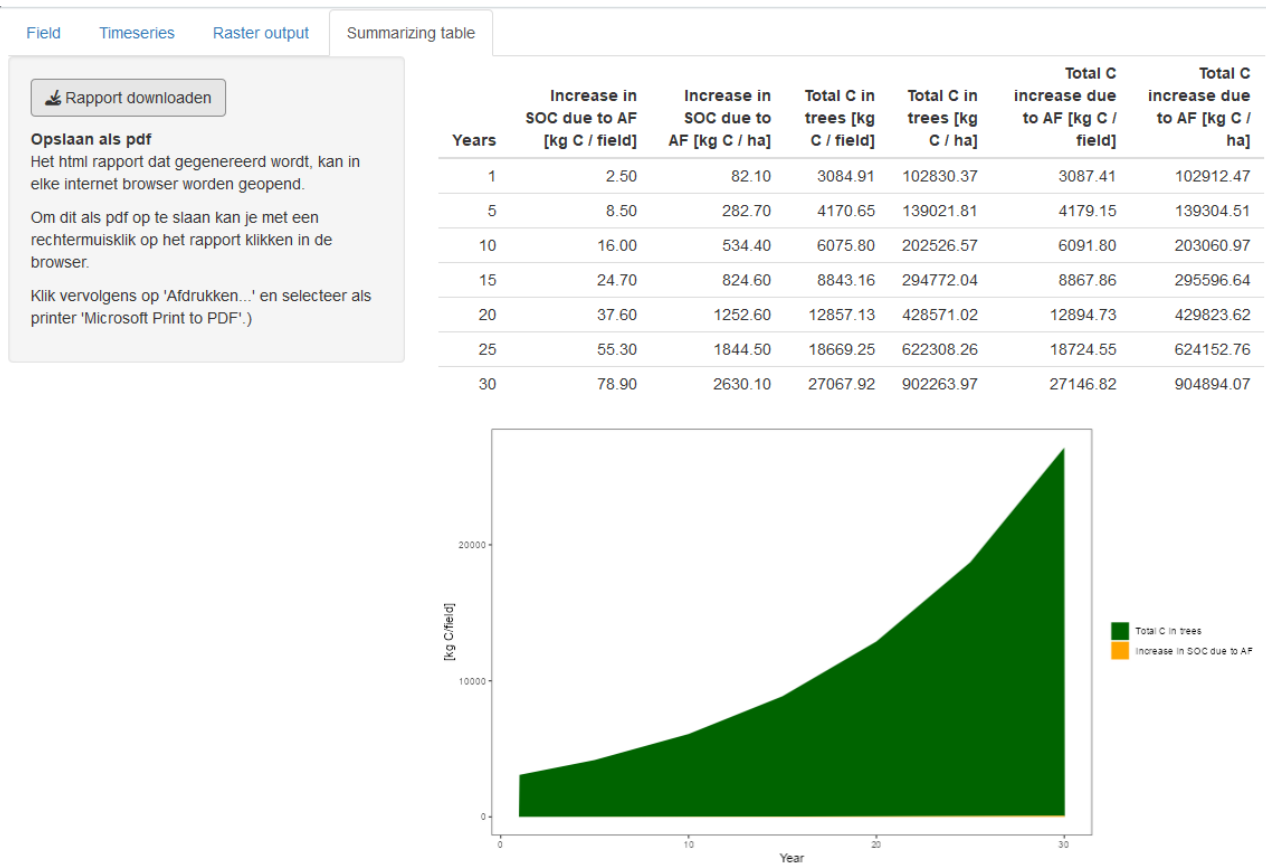


You can choose the year of the projection from the 1st year to the 30th one, thanks to the graduated scale.



→ Finally, you can open the last tab of the tool, titled “*Summarizing table*”.

4. Summarizing table & Report

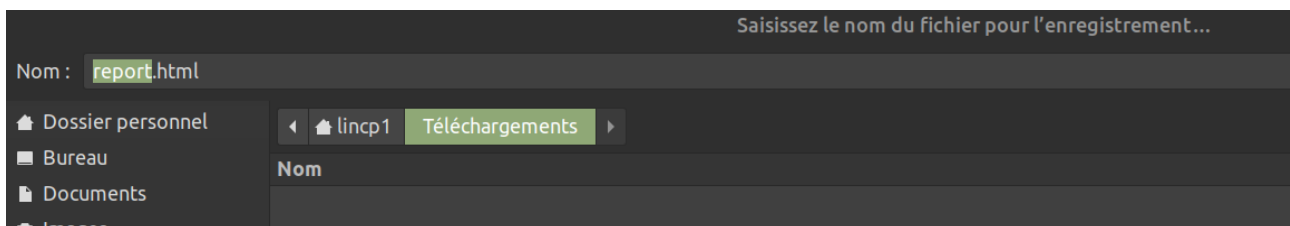


On the left of the tool's screen, you can download a report containing all the figures generated by the model, by clicking on the "[Rapport downloaden](#)" button.

a) Download the HTML report

Once you have clicked on this button, a new window will open to let you choose the folder in which you want to save the web version of the report.

You can change the name of the file, and/or the folder. Then, save the file by clicking on the "[save](#)" button.

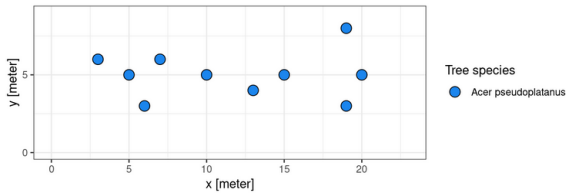


As you can see above, it is a file in HTML format. This is why we will look at how to print the report, or save a version of it which does not require an internet connection, by transforming this HTML file into a .pdf file.

b) Open the HTML report

Carat output

Het plan voor aanplanting:



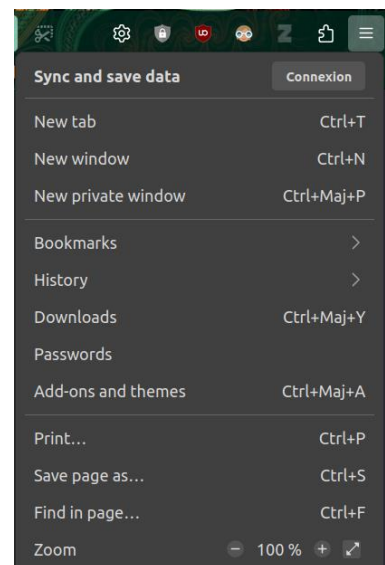
If you click on the “report.html” file to open it, a new window (or a new tab) will open in your web browser ; the top of the page will look like the example opposite, with a representation of your field and trees.

Afstand tot dichtsbijzijnde boom:

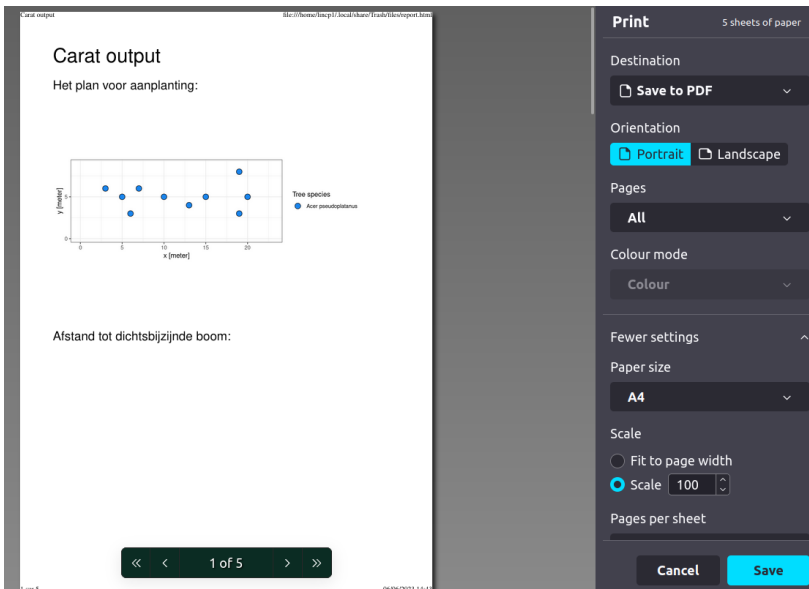
c) Print the report or save it into .pdf format

Once you see the report in your web browser, click on the icon in the top right corner of the page. Generally, it looks like *3 points* (e.g. on Google Chrome) or *3 lines* (e.g. on Firefox).

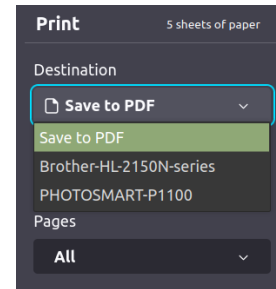
Then, choose “*Print*”.



A new window will open, to help you configure the printing options (orientation, pages to print, colour mode, paper size,...).



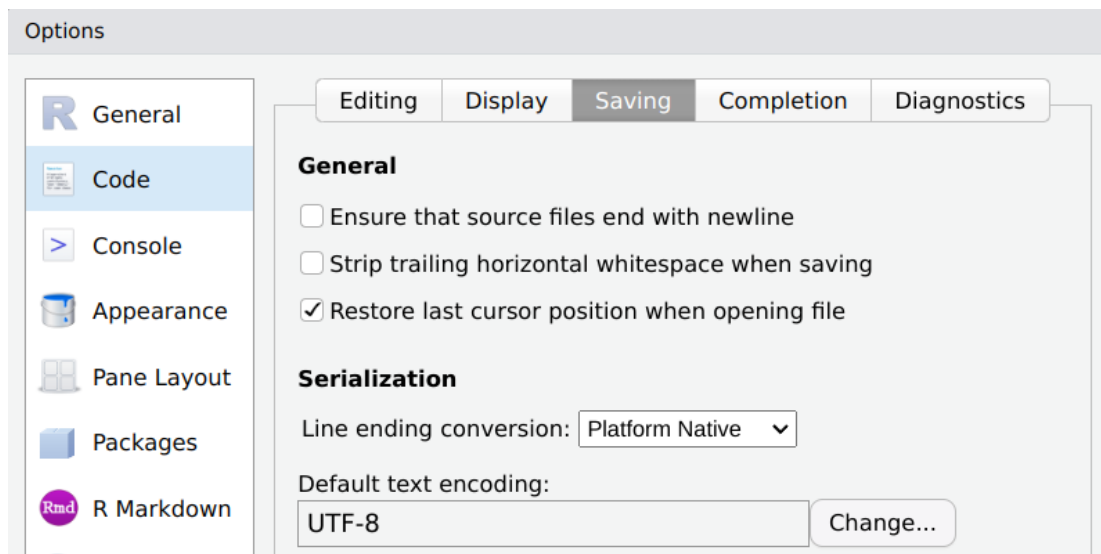
Click on the drop-down “*Destination*” list to choose if you want to :
 → Print your report, by selecting a printer ;
 → or to convert it into a .pdf file with “*Save to PDF*”.



III – With Rstudio : how to solve frequent bugs / errors

1) While opening the app.R script, if Rstudio displays the opened script as empty : this probably means that the software is not using the right encoding (UTF-8).

→ To change this configuration of the software : **Tools > Global Options > Code > Saving > "Default text encoding" : UTF-8.**



2) If the tool cannot run, and/or if Rstudio displays the error message below when you try to run the tool...

```
> runApp('F:/0-Docs bibli/1-Stage M1/1-ILVO activities/0-Bibliography and data/CARAT
/CARAT_230510')

Listening on http://127.0.0.1:7517
Warning: Error in &&: 'length = 3' in coercion to 'logical(1)'
 1: runApp
Error in is.call(funBody[[idx]]) && as.character(funBody[[idx]][[1]]) == :
  'length = 3' in coercion to 'logical(1)'
```

...check the R version of your software ; it is normally displayed on the top of the Console, when you open Rstudio. If the version is not **R.4.1.2** or **R.4.1.3**, **change it to one of these**.

