ARBOCARTO
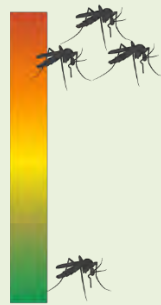
ARBOCARTO v2

PREDICTIVE MAPPING TOOL FOR AEDES MOSQUITO POPULATION DENSITIES
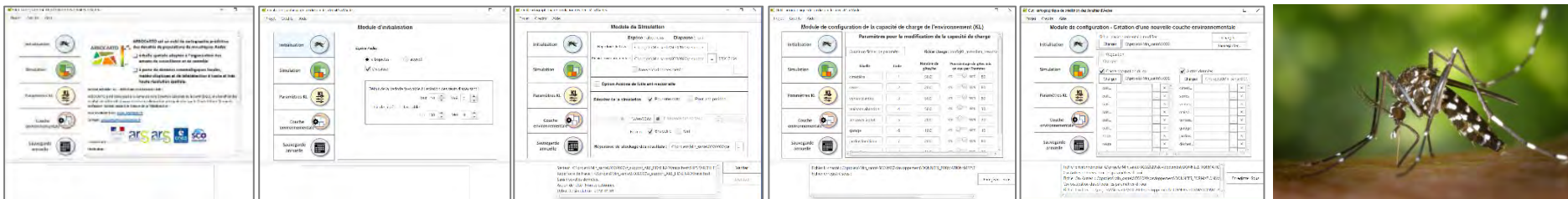
USER MANUAL

Version 1 - June 2022

CONTENTS

GLOSSARY

Vector layer/geographic file: digital file made up of graphic objects with intrinsically associated semantic data, and located in a spatial reference frame (X,Y)

EPSG: code characterizing spatial reference systems, including projections

Environmental file: geographic vector layer representing the graphic objects used to model mosquito abundance and density

IRIS: geographic vector layer corresponding to the INSEE division of the French territory, grouping together 2000 inhabitants. Data source available for the whole of France (including ultra-marine territory)

KL : environmental carrying capacity (*concept explained on p7 of the manual and detailed in the Methodological Guide for data production for Arbocarto v2*)

Kml: keyhole markup language, an XML-based format for simply representing graphic objects and possibly alphanumeric information. This format was initially used by Google Earth and has become a standard language approved by the Open Geospatial Consortium.

NDVI: normalized difference vegetation index of the red and (near) infrared channels. This index is associated with the chlorophyll activity of plants, and allows to produce a layer "vegetation" by thresholding the index.

Black spots: known places that can be the source of numerous mosquito breeding sites, this is a source of data that complements the generic land use classes. These black spots, for example cemeteries, can be downloaded from the internet, other data will have to be created according to the field knowledge of the actors in each area.

GIS: geographic information system

SI-LAV: Information system for vector control of the Ministry of Health

Shp: extension of vector geographic files in shapefile format, also known as shapefiles

THEIA: continental surface data and services cluster, created at the end of 2012 by nine French public institutions involved in earth observation and environmental sciences (*for more information* https://www.theia-land.fr/)

UA: Urban Atlas, land use financed and distributed by the European Union. It covers large urban areas of at least 50,000 inhabitants and has a detailed nomenclature in the urban area. The data is available free of charge and produced every 6 years.
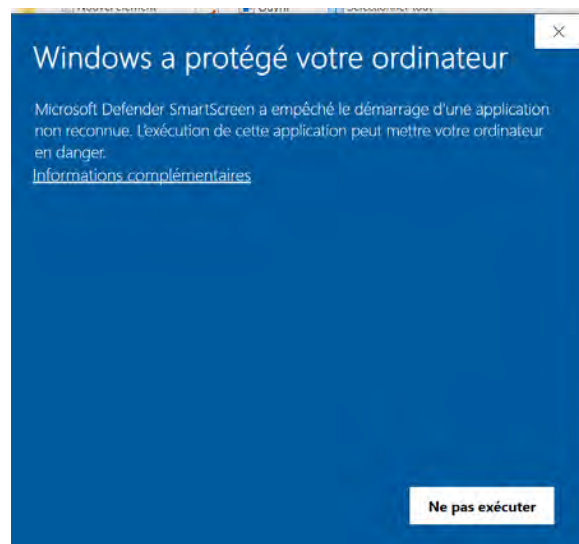
Installation

The ARBOCARTO interface requires JAVA (JRE v8 minimum). All the files necessary for the application are stored in the directory named Arbocarto, which will be created at the end of the installation. The wizard also installs JAVA if it is not installed on the computer or if the version is obsolete.

Note: ARBOCARTO is an application of the French Ministry of Health. To download the installation executable, you must first fill in the form in the appendix of the [Information Note nº DGS/VSS1/2020/15 of January 13, 2020 concerning the distribution of the ARBOCARTO tool](#) *and send it to the DGS (Direction Générale de la Santé).*

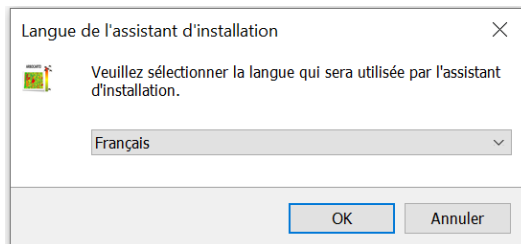To start the installation double click on ***arbocarto-install***

Note: Depending on the settings of the Windows workstations, the following window may appear. You can trust the authors of the application and ignore the Windows warning message to continue the installation.

Click on "*Additional Information*",
 then in the next window on
"*Execute anyway*"

You can click on "yes" in the next Windows window.

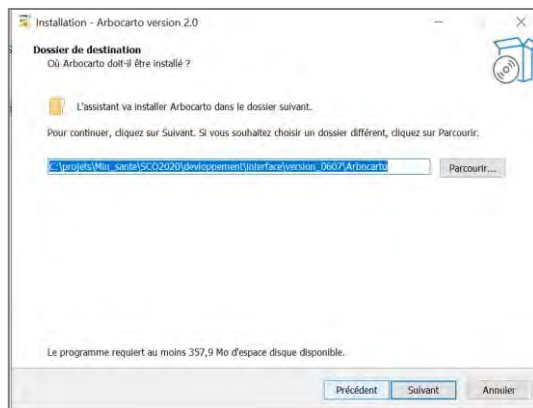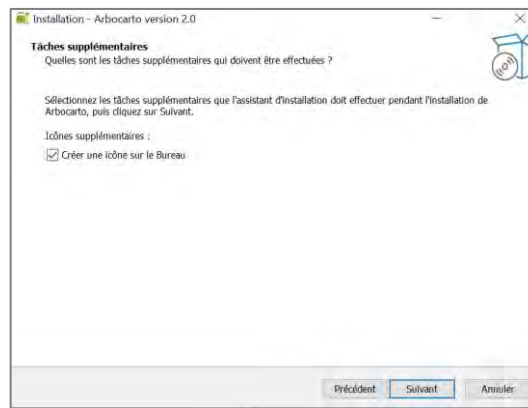Follow the instructions of the installation wizard:

Validate the license

Modify the installation path if necessary   *Choose to create an icon on the desktop for direct access to the Arbocarto V2 application*
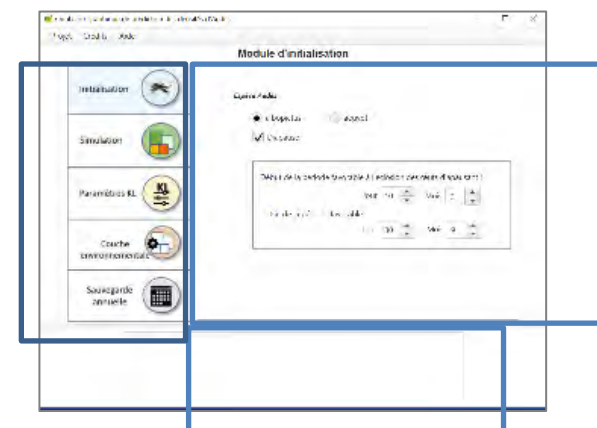
Uninstall

To uninstall the ARBOCARTO v2 application, double click on ***unins000.exe*** which was created during installation. The uninstallation executable is located in the *Arbocarto* directory.

General help

The ARBOCARTO application has an Interface consisting of three main parts:

- On the left the menu with the different modules to be activated
- In the center, the parameters to be specified for each module
- At the bottom, a warning or information space about the good progress of the treatment.

In the upper part, help, credits and closing the application are also available.

INITIALIZATION module, to be activated at the first use of the tool, and later only if you wish to launch simulations for a different species or different behavior: species management, diapause.

SIMULATION Module For operational use, e.g. weekly, or to analyze model predictions, test control strategies or for communication actions.

CONFIGURATION modules, to modify reference files with support for updated localized knowledge

Environmental carrying capacity configuration files

Environmental file taking into account new configuration files of environmental carrying capacities, or new data sources such as vegetation (binary raster file of thresholded NDVI) or geographic vector files (land use classes, additional data)

Module ANNUAL BACKUP, saving of intermediate calculation file(s) on December 31.

Each time a geographic file is created (SIMULATION, Configuration - new environmental file, Annual backup modules), a txt file is also produced storing the history of the parameters used.

Concept of "Environmental carrying capacity"

The carrying capacity of the environment can be compared to the maximum number of larvae that can be present in the environment. It is therefore related to the number of potential larval sites per hectare: sites that can be watered by rainfall (Klvar) and sites that can be watered by humans, particularly through watering (Klfix).

These two variables are taken into account in the functions and equations of the mechanistic model (for the larval and pupal stages).

In the absence of quantitative data collected in the field, the tool relies on various sources of information to get as close as possible to reality:

- The land use allows to classify the space in large classes. For each of these classes, the KLfix and KLvar are defined, based on observations of entomological surveys, and data from the literature, consistent with the current state of knowledge.
- The presence of vegetation is a factor considered favorable to the presence and maintenance of the mosquito. Taking it into account therefore increases the carrying capacity defined above for the land use classes. This is especially true since we rarely have precise information on the presence of gardens or flowerbeds in the various land uses available.
- To refine the modeling results, one can:
    - specify the use of the land, via other data sources. We retain those known to provide breeding sites for the species of mosquito considered (cemetery, plant sales area, waste disposal site, etc.)
    - complete the knowledge with specific information specific to each site (abandoned house, terraces with plots, ...).

These two categories can be grouped under the term "black spots".

EVOLUTIONS DEMONSTRATOR (ARBOCARTO V1) - ARBOCARTO V2 TOOL

What changes with ARBOCARTO v2:

- A single executable

    - regardless of the geographical area of the model, under temperate or tropical climate

    - for both species, *Aedes albopictus* (diapausing or not) and *Aedes aegypti* ;

- Flexible integration of meteorological data

- Integration of various vector control scenarios and their combined action

- Adaptation/correction of small dysfunctions of the V1

- Ergonomic improvement (reorganization of some parameters in the modules, addition of buttons to save user parameters and reload them later,...)
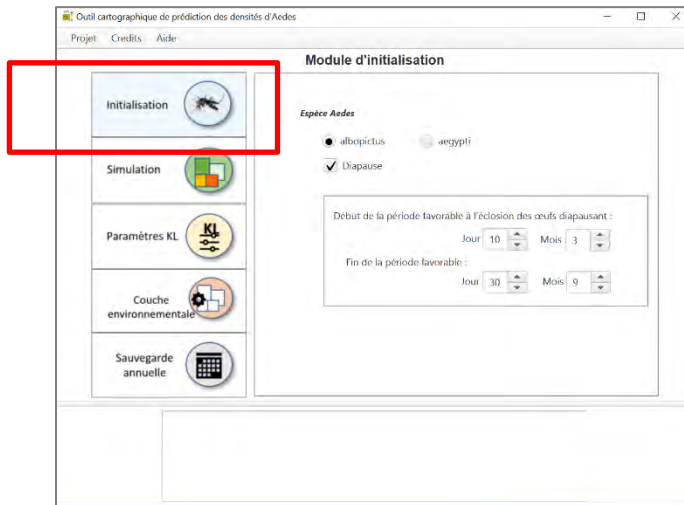
The application has been completely rewritten.

ARBOCARTO V2 brings an ease of use for the territories concerned by several mosquitoes, a better management of the future evolutions of the application.

INITIALIZATION Module

Activation by *Aedes* species

Creation of an initialization file concerning the parameters adapted to the species and the general context of the site

How it works

Selection of the *Aedes* species

In the case of *Aedes albopictus*, specify whether diapause is observed in the study area. If so, specify the date of the beginning of the period favorable to the hatching of diapausing eggs of the mosquito (by default, March 10) and the date of the end of the period favorable to the hatching of the eggs (by default, September 30)**.**
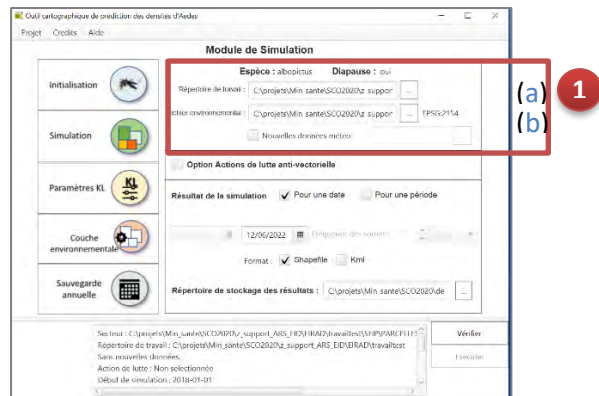
In general, the ***Initialization*** module only needs to be activated at the first use. However, depending on the geographical location (e.g. Mayotte), the user may decide to model the population dynamics of *Aedes albopictus* or *Aedes aegypti* on his territory. In this case, it must be specified beforehand via the INITIALIZATION module.

Remark: while waiting for the elements of the entomologists to model more precisely the entry in diapause, it was decided with them, at the date entered by the user ("*end of favorable period*"), not to consider any more the hatching of the eggs in the equations of the model. All the functions of passage from one stage to another (larvae > pupae, pupae > emerging adults, etc.) continue however. Also, at the beginning of the favorable period and depending on the meteorological elements, the egg>larva transition function will be reactivated (= eggs can start to hatch).

SIMULATION Module

Creation of the geographical file for the prediction of the *Aedes* density(s) according to the parameters defined by the user.
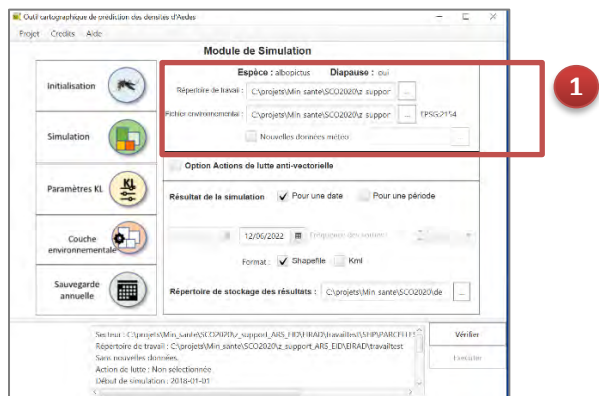
How it works

① Space "starting" elements of the modeling

The user is reminded of the species last selected in the "Initialization" module and if he/she has specified the presence of diapausing eggs in his/her territory (a).

1.1) Selection of the working ***directory: "root" directory*** for data storage. This root directory contains in particular the subdirectories concerning the weather stations and the historical weather records (respectively SHP/METEO and CSV/METEO). *Cf. Methodological guide to data production for ARBOCARTO V2.* This allows ARBOCARTO to automatically find the directories related to the weather data and to facilitate the following entries in the interface by the user.

1.2) Selection of the ***environmental file*** (Shapefile format). The file characterizes the geographical entities for which the simulations of mosquito densities are performed. It can be for example an IRIS division, or a finer division. It is necessarily projected (= the cartographic projection is defined). ARBOCARTO displays the EPSG code of the projection, once the file is selected by the user, on the right of the file (b). The environmental file must contain at least the following attribute information: SurfHA (= area in hectares), Altitude (expressed in meters - integer) and the fields characterizing the carrying capacity of the environment KLfix (impounded by human action) and KLvar (impounded by rainfall).
These fields must be filled in <u>before</u> launching the modeling on the file.
The surface of the geographical objects of the environmental file is <u>at least 3ha</u>.

Remarks:

- *To modify or fill in the environmental carrying capacities, use a GIS software or the module "Creation of an environmental layer".*
- *To speed up processing times, when you have more than 4 years of weather records, use the file from the Annual Backup module, the one as of December 31 of year N-1, only the weather records of the current year will be used (given that the backup as of December 31 has been established with all previous records).*

1.3) Specify if the simulation is based on new meteorological records, previously downloaded and stored in a dedicated directory, to be selected in this case, **otherwise the simulation will exploit the existing meteorological dataset**.
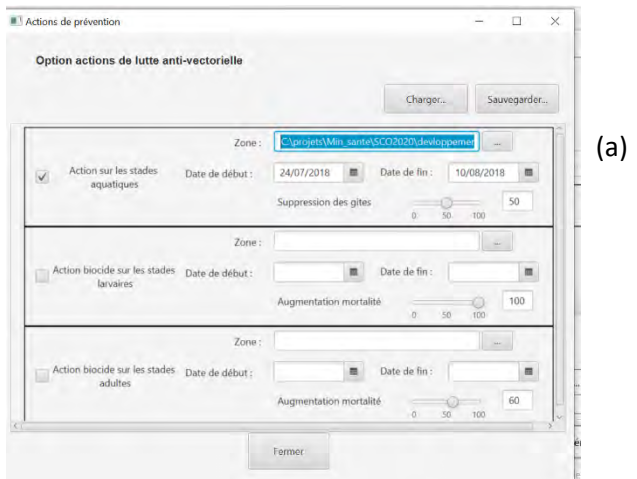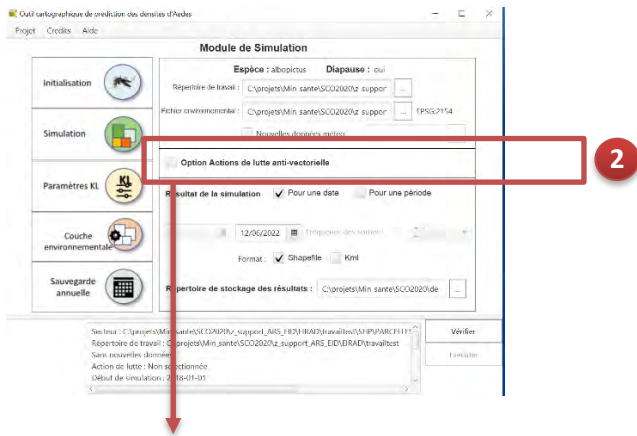
Checked box: new statement taken into account for modeling.

When the box is checked, ARBOCARTO automatically integrates the new records into the "historical" dataset. It will no longer be necessary to check this box, unless new data are uploaded.

The "historical" weather dataset is stored under the WORK/CSV/METEO tree.

<u>New statements MUST be stored in a different directory</u>.

As many weather report files are needed as there are weather stations in the study area. The records bear the name of the station. (*Cf. Methodological guide for data production for ARBOCARTO V2*)
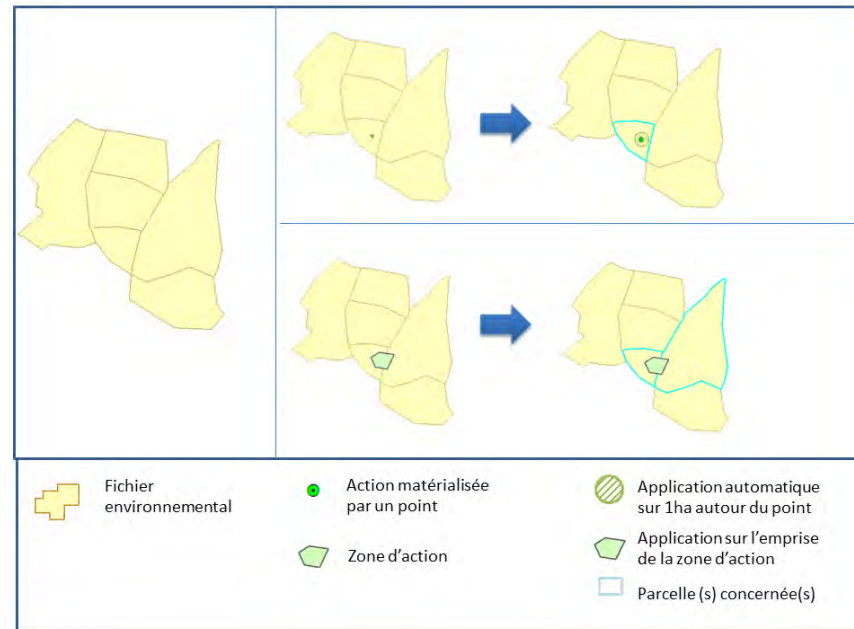
(a)

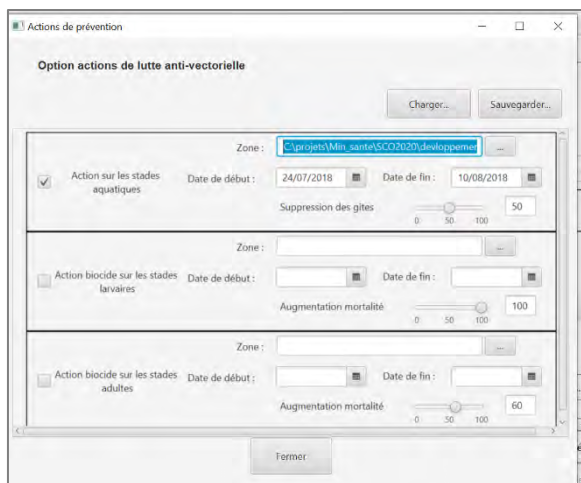**2** *Optional space*: check box "Vector control actions option"

To be checked in vector control scenarios. When checked, it opens a new window.

Check one or more of the proposed actions.

(a) then *select the geographic file*, *describing the area* (the attributes are optional but the file must be in the same projection as the environmental file (same EPSG code)). The location can be defined as polygon(s) representing the exact extent or materialized by one or more point(s). ARBOCARTO will automatically apply a one hectare zone around the points.

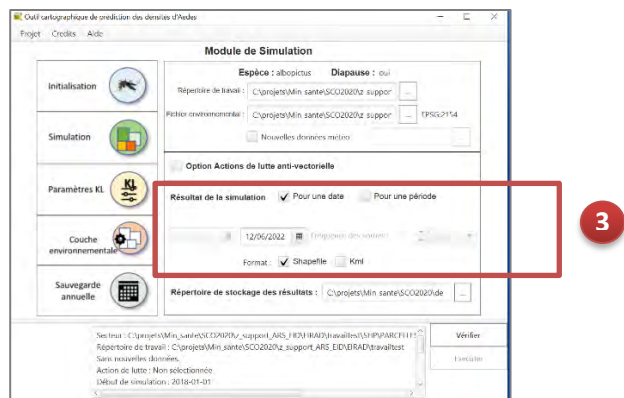By definition, the action is only effective within the zone.

(b) Specify the **period** during which this action takes place, by filling in "start date" and "end date". The end date must be prior to the end date of the requested simulation.

(c) Using the cursor, or by entering the value directly, indicate the impact of the action (**decrease in the number of nests** or **increase in the mortality** of the stage concerned, on this area).

(d) You can save all the vector control settings by clicking on the "*Save...*" button and call up this scenario later by clicking on "*Load...*". The user is free to change the saved settings via the same interface.

When you have finished setting up the scenario, click on the "Close" button or via the cross in the window.

However, if you do not want to take the settings into account right away, simply uncheck the option in the initial modeling window.

TIP TO KNOW THE DATES OF THE WEATHER SURVEY

By clicking on the "Check" button (5), the dates are then updated in the lower console of the tool (6). If, on the other hand, there is an error in the meteorological records or in the choice of dates in relation to the available records, a message window will appear.

③ *Space Modeling Result*:

Specify the type of record, by checking the desired boxes:

A date: for a weekly operational use for example
It is not necessarily the last date of the weather report. The user specifies the modeling date ($2^{ème}$ calendar to be filled in, the 1er is grayed out with this option). If the user has also checked a modeling on a period, the 2 calendars are active to define the modeling period. The modeling date for a date will be produced for the end date of the period (=$2^{ème}$ calendar).

The period: for a dynamic temporal follow-up - *Be careful, the processing times are necessarily longer.*
It is then necessary to fill in the 2 calendars (start date and end date of the modeling recording), either by selecting the day in the calendars, or by typing the date on the keyboard, in the latter case finish the entry by clicking on the "*Enter*" key on the keyboard
The user can also modify the frequency of output of the modeling results (by default 7 days): variation in number of days or months thanks to the two lists proposed

Remarks:

The output file will describe the abundances of the different stages of the mosquito at the frequency defined by the user over the simulation period, except if the period includes the initialization year of the model, in which case the abundances will be provided from the following year.

If you are using an annual backup file, only later dates can be entered. An alert message in the console at the bottom will remind you of this.

The end date of the modeling cannot be later than the last date of the weather records.

:

SHP format: for later use in a geographic information system. The mosquito densities corresponding to each life stage are recorded in the result file. This format can also be integrated and parameterized in the SI-LAV.

kml format: for use in Google Earth or direct integration in the SI-LAV. The SI-LAV does not manage "multi-date" information. Only simulations for a date can be added very simply in the SI-LAV. The legend is automatically included. The simulations in kml format only map the total density of adults per hectare.
Classes are defined as follows:

1 : < 100	6 : 1000-1250
2 : 100-250	7 : 1250-1500
3 : 250-500	8 : 1500-2000
4 : 500-750	9 : 2000-2500
5 : 750-1000	10 : >2500

(4) Define the **directory for writing the results**

(5) Check that the parameters entered are consistent with the data. Click on **the "Verify" button**
If no errors are detected, the **"Run" button** becomes active, allowing the user to start the simulation.

A " Cancel " button allows you to stop the simulation.

(6) The files are generated when the text box **"processing complete**" is displayed.

the name of these files is the same as the name of the environmental file, followed by the date or dates chosen at point (3) and then by the indexing of file "v1" at the first modeling. If we restart the modeling without changing the elements of (1) and (3), a new series of files will be produced and named in the same way but the index will be incremented: V1 into V2, etc.

Note: In addition to the simulation files, a text file (.txt) is generated that summarizes all the user parameters of the **simulation** module. The .txt file has the same name as the environmental file + the date and time of the simulation.
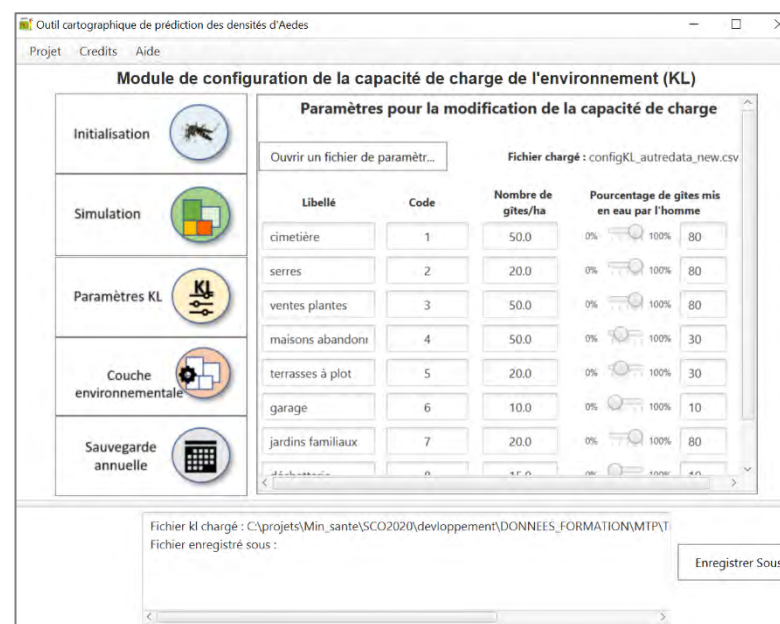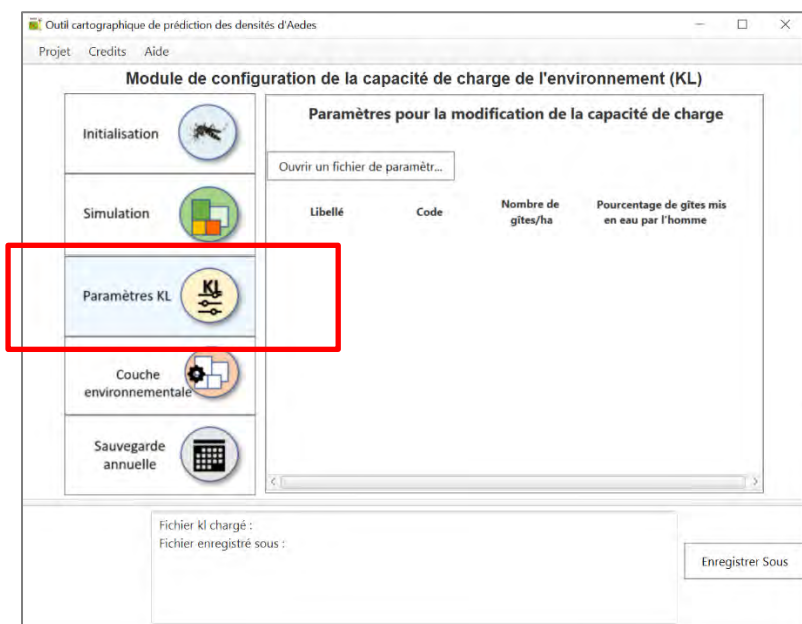
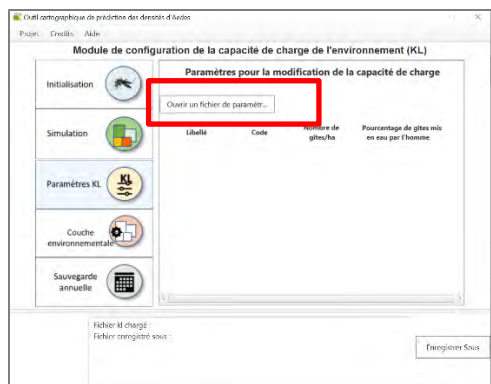# CONFIGURATION Module - Environmental Carrying Capacity (KL)

The environmental carrying capacity can be compared to the number of larvae in potential breeding sites/ha: sites that can be watered by precipitation (Klvar) and sites that are watered by humans, particularly via watering (Klfix). *(see general help)*

In this module, the user can modify the parameters used to calculate Klfix and Klvar, linked to the different land use classes or to other data sources ("Black Points").
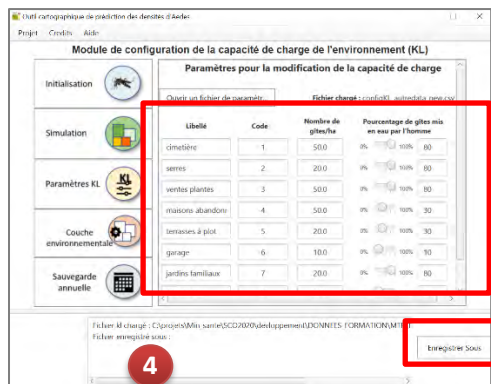
Initially, two configuration files of the environment carrying capacities respectively related to the land use and the additional data are delivered with the tool: "configKL_ocs_UA_new.csv" and "configKL_autredata_new.csv".

By changing the parameters via the interface of this module, a new file (.csv) will be created.

Interface at module launch

Interface after loading a file (here types of black points)

How it works

1 Select a carrying capacity configuration file for the environment

This is a csv file.

Automatically the list of land use classes or type of "black spots" will be displayed (=*dynamic information by reading the content of the .csv file*)

2 The parameters "nb of breeding sites/ha" and "% of breeding sites filled by human" are defined in an identical way for all the geographical objects of the same land use class or same type of black spots.

Modify the parameters according to your knowledge

The percentage of man-made caves is changed by moving the cursor. Use the arrows on the keyboard, to refine this percentage if necessary or enter the value directly

3 Define a name for the .csv file that will contain your changes, by clicking on "Save as".

4 The file is created when the text box at the bottom of the application window shows "***processing complete***".

Note: since the configuration files are text files, you can also add new types of black spots directly using a text editor and fill in the other fields of the .csv file (e.g. add "Boat" and then increment the identifier (code field), etc.) ==*[see Methodological Guide for Data Production for ARBOCARTO V2]*==.
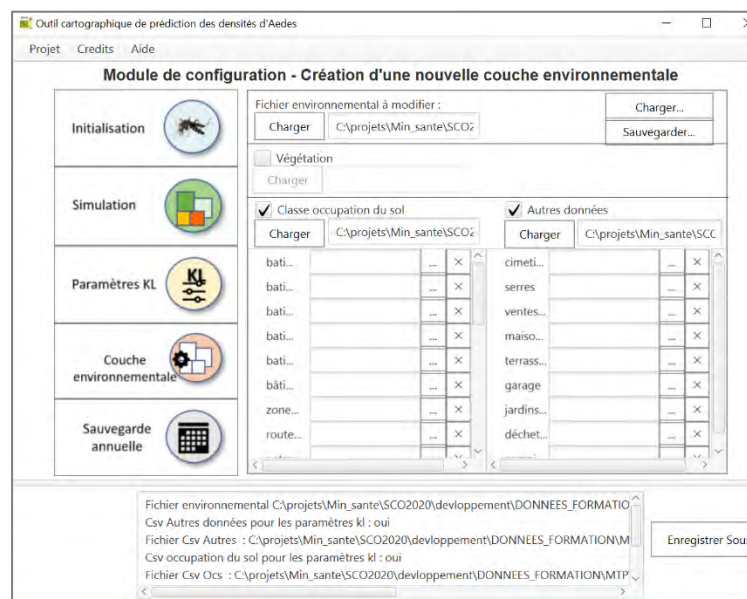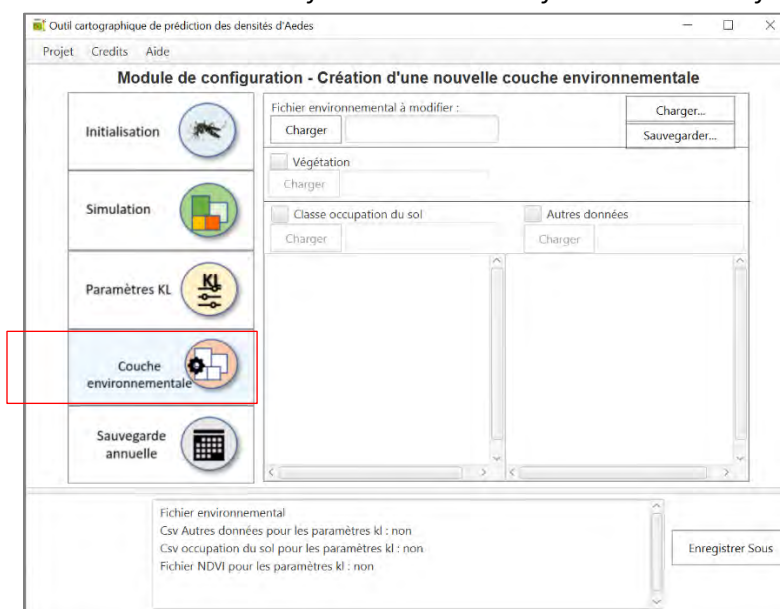
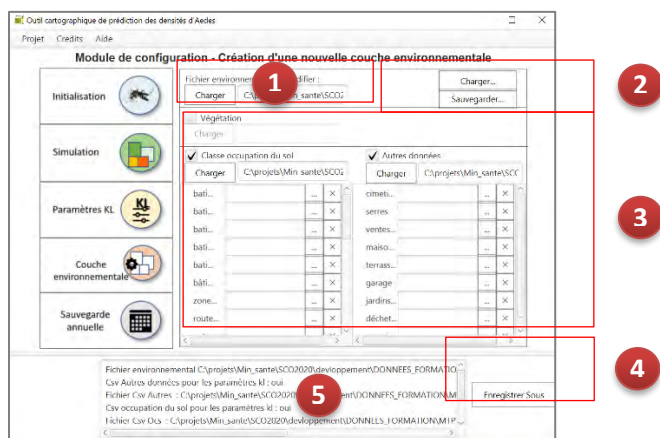# CONFIGURATION module -Creation of a new environmental file

The environmental file characterizes the geographical entities for which the simulations of mosquito densities are performed. It can be an IRIS division or a finer division. For each geographical entity, the environmental carrying capacity values are defined.

The module here allows you to create or update the environmental file with, for example, new parameters for the carrying capacity of the environment (defined via the "Configuration – Environmental Carrying Capacity" module) and/or the taking into account of vegetation. The initial environmental file will not be overwritten. A new file will be created.

It can then be used in future simulations of mosquito densities. (via the activation of the SIMULATION module)

Interface at the launch of the module interface modified according to the user parameters

1 Selection of an environmental file <u>to modify</u>. For example, it can contain only the values of the carrying capacity of the environment established only from the land use classes in order to add, by this module, carrying capacities coming from complementary data of land use or by taking into account the presence of vegetation. Or, the environmental file to be modified does not yet have any associated environmental carrying capacity (KLfix and KLvar fields at zero)
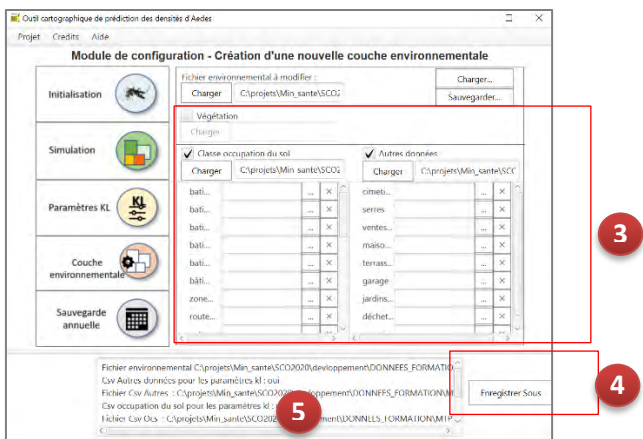
> *Note*:
>
> *The "Configuration - Modification of the environmental carrying capacities" module generates a CSV file with new KL values.*
>
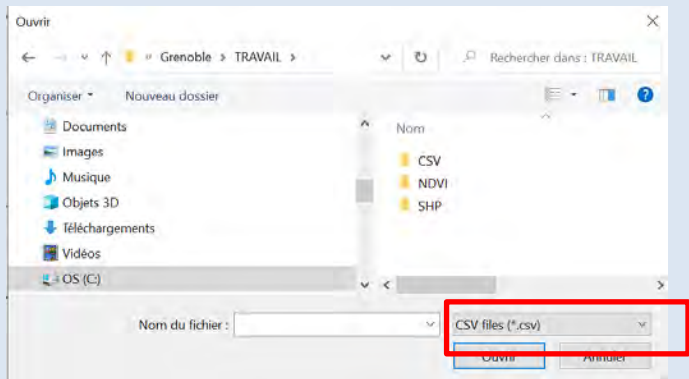> *The module "Creation of a new environmental layer" allows you to assign these new values to an environmental file.*
>
> *To generate the modified csv file, you must **first activate the "Configuration - Environmental Carrying Capacity" module**.*

Note:

> *If the user wants to save all the settings, he/she should click on "**Save...**" (box 2) before clicking on the "Save as" button (box 4). (box 2) <u>before</u> clicking on the "**Save as**" button (box 4)*

2 Optional: use of the "*Load...*" and "*Save...*" buttons

Save: generates a text file (.csv) containing all the parameters (name of the environmental file to be modified, the checked boxes, the csv files characterizing the carrying capacity of the environment and the associated geographic files.

The user decides on the storage location and name for this environmental file creation <u>settings file.</u>

Be careful not to confuse it with the "Save as" button described in point (4)

Load: *The* purpose of this feature is to automatically take over in the interface all the parameters used during a previous saved configuration (via the button described above (2)). The user selects the settings file and is free to modify the configuration of the parameters in (1) or especially in box 3.
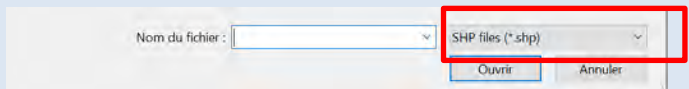
③ Via 3 checkboxes, the user can integrate environmental carrying capacities from different sources:

- "Vegetation", and select the corresponding raster file (NDVI)
- "Land use"
- "Other data" for the addition of black points

Select for the last two cases the environmental carrying capacity configuration csv file associated with either the land use or the other data

A list is automatically displayed listing the different land use classes or different types of additional data present in the configuration file.

Select the corresponding geographic layer for each type by clicking on ⬚ .

To remove the data file association, just click on the cross after the file name.

④ Finally enter a name for the new environmental file that will be created.
You can also change the storage directory of this file.

⑤ The new environmental layer is generated when "**processing complete**" is displayed in the message area. A .txt file is also automatically generated summarizing the user parameters in the directory where the new environmental file is saved.

*Note: * if the user knows from the field that the mosquitoes present in a cemetery can impact a neighboring crown, it will be necessary to create a buffer zone around this cemetery using GIS software. The enlarged area of the cemetery will then be added to the other entities of the "cemeteries" layer to constitute the file to be taken into account by ARBOCARTO*

Tips: *after clicking on the various "load" buttons, remember to look at the bottom of the Windows window, the type of extension of the expected file*

Step Three:

Step 1:

ANNUAL BACK-UP module

This module saves the status of abundances and other internal model parameters as of December 31 of year N-1.

The resulting backup can then be used as an environmental file for the SIMULATION module, thus improving the processing time for future simulations.

The backup can only be created if the study area has at least two years of daily weather records.

The annual backup module generates as many geographic files as the number of years present in the weather records.

How it works

1. Select the working directory: "root" directory for storing project data.

2. Select the geographic layer, which represents the entities for which the simulations are performed. The attribute table of this geographic layer must contain at least the carrying capacity fields of the environment and an identifier.

3. Define the storage directory for backups.

   The management of product file names is automated.

   Note: Historical weather records should be kept

Useful links and information

ARBOCARTO application website: https://www.arbocarto.fr/

Current version: v2 - year 2022

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Owner of the application : Direction Générale de la Santé, French Ministry of Health

Co-authors of Arbocarto: CIRAD and MARIE DEMARCHI

Application distributed under **Cecill-C license**

Funding for v2: CNES - SCO project, link: https://www.spaceclimateobservatory.org/arbocarto-v2-mainland-france