SMART AQUAPONICS

Smart Aquaponics

SAM ("Smart Aquaponics Model")

User Guide

(January 2022)

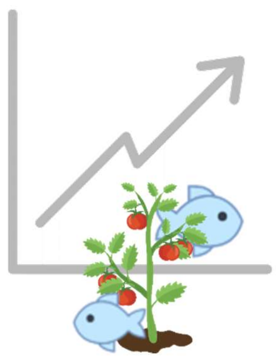


Table of contents

1. Introduction

The modeling framework created within the Smart Aquaponics project will be implemented on the Smart Aquaponics App. However, it is also interesting to keep a scientific-oriented interface where the user has total control over every parameters of the system. The interface presented in this document is an access to the raw and complete version of the model. This tool is available online and access can be granted to authorized users.

This document explains how to use the modeling framework with the online interface developed by Junia, the partner of the Smart Aquaponics project responsible for the management of the servers. While using the model, please keep in mind that there is still room for improvements and that the framework can easily be updated. You might encounter errors, or non-logical results. We encourage you to first check the properties of your simulation. If the modeled system is realistic and all the parameters have plausible values and you still get odd results, please to contact Ir. Benoît Stalport (b.stalport@uliege.be) for support or if you have anything else you would like to report.

1. Generalities

The modeling framework was developed using the Python programming language, which means that a Python interpreter (software) would normally be needed to run a simulation. The source code can be accessed at the dedicated Git: https://gitlab.uliege.be/B.Stalport/smart-aquaponics. However, in order to offer the opportunity to non-coders to use the modeling framework, it has been implemented on a server that can be accessed through a dedicated webpage. This page facilitates the access and the user only needs to configure and upload a configured file in *.csv* format, so that any spreadsheet handler can be used for the configuration.

This document is a step-by-step guide for using the Smart Aquaponics Model ("SAM"). First, the use of the webpage is explained. Then, the "Global data" file is presented. This file is the specific database of the model and the user does not have the possibility to make any modifications to this file. However, it needs to be accessed to gather information for the configuration of your simulation. Finally, the "User data" is the file that you will configure with the data for your simulation. It is presented into more details. The modeling framework generates three kinds of results: a text file with all the raw numerical results, a summary file that provides comments and advices on the simulation and a few automatically generated figures. These steps are summarized in the figure 1.

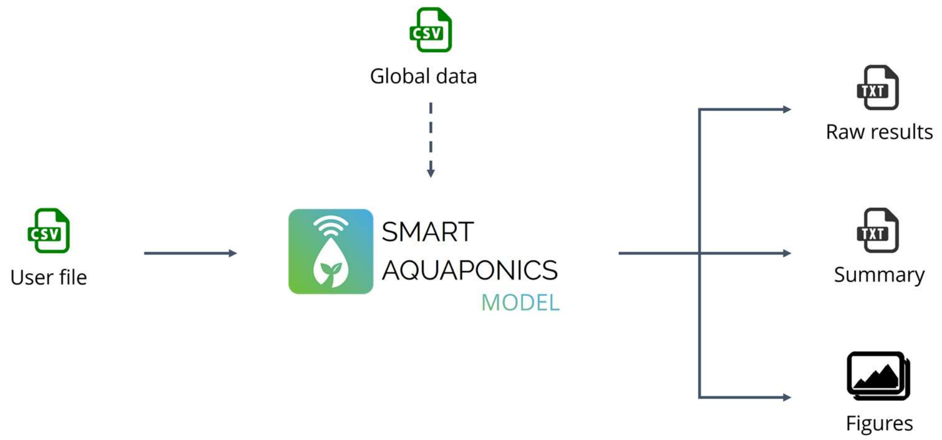


Figure 1. *Operation of the Smart Aquaponics Modeling Framework*

2. How to use the web interface

To use the modeling framework, you can create your account on our website https://www.smart-aquaponics.com/modeling. Once you have your account, you can access the website.

Once on the website, log in using your account. You will then get to the following page:

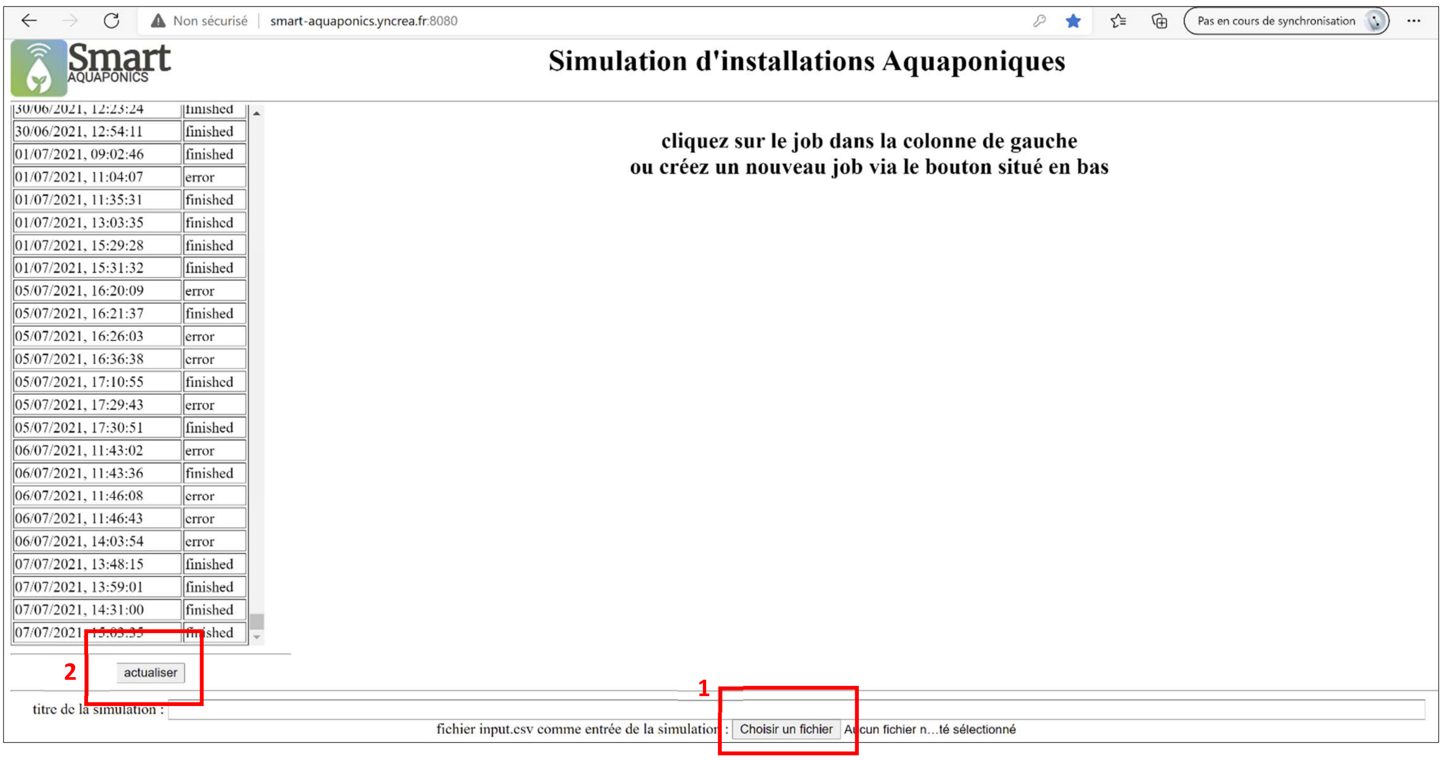


Figure 2. *Webpage workspace - generalities*

In case of problem: contact info@smart-aquaponics.com, or Vincent Lefevere vincent.lefevere@yncrea.fr.

On this page, follow these steps:

1. Click “Choisir un fichier” and choose your configured “user_data.csv” (more information below, under 6.)
2. The model is now running, you can click on “actualiser” from time to time, to see if the process is finished (see under “status”)

Once you started a simulation, you can click on it. Note that all information will only be available when the computations are finished. When you click on one of your simulations, you will get to the following screen (**Fig. 2**).

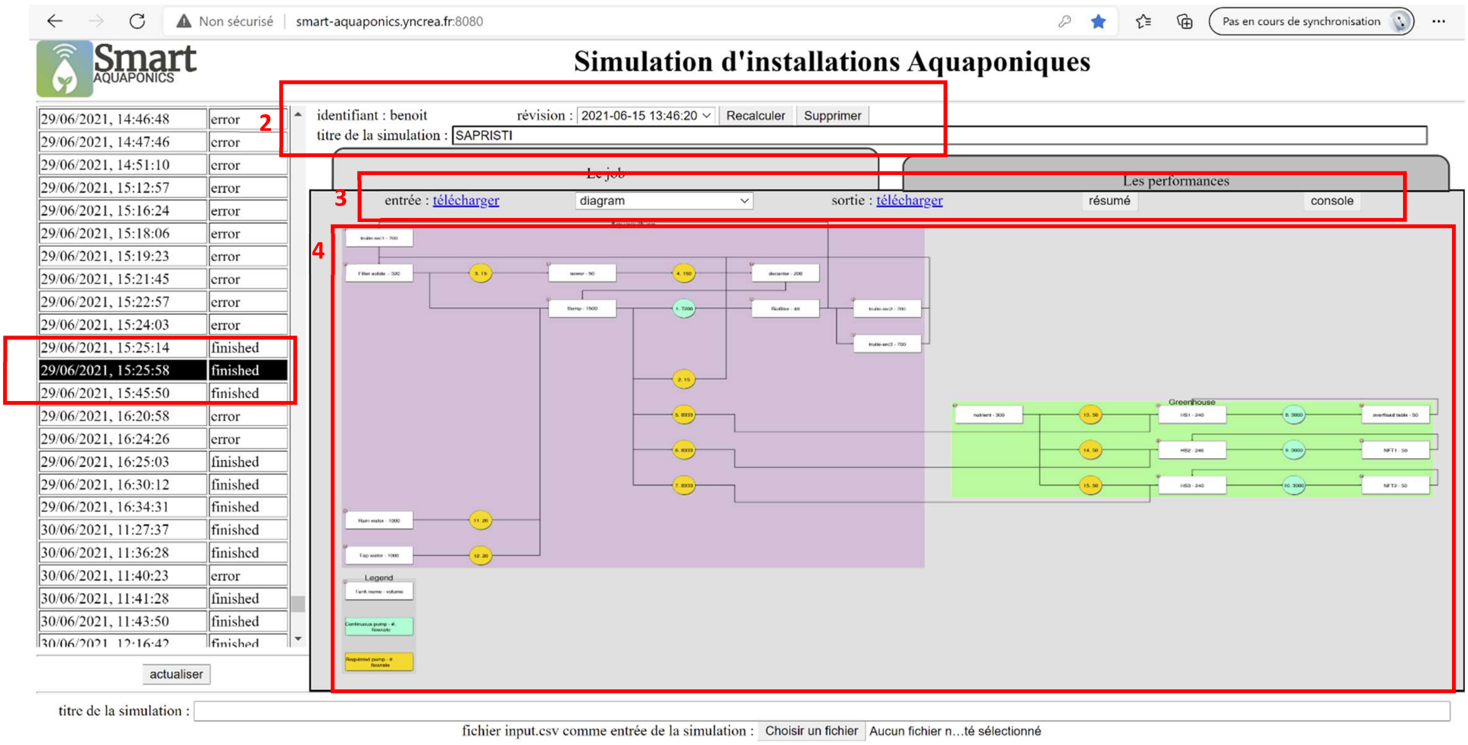


Figure 2. *Webpage workspace – simulation information*

On this screen, several tools are accessible:

1. Choose the simulation for which you want to access the results (results accessible only if status is “finished”)
2. In this menu, you can give a name to your simulation, delete it and restart the computation process if needed
3. In this menu, you can download the simulation input file, choose which figure to show in zone 4, download the exhaustive results text file, access the simulation summary and the Python console.

4. The drop-down menu from zone 3 allows you to choose from a list of automatically generated figures from the results of your simulation. These figures include a diagram of the system, and several time series plots of the parameters of interest of an aquaponic system. To download a figure, simply click on it.

   Simulation summary ("résumé")

   The summary tool provides a short feedback on the simulation. It summarizes the highest and lowest values reached by the parameters of the tanks and the rooms and gives advices if these values are too extreme. It also provides some financial information, and notifies the user if some plants or fish died in the simulated setup and if some tanks overflowed in the room, due to a wrong system configuration.

   Python console ("console")

   The console shows the messages directly generated by the underlying Python process. If the input file is wrongly configured (wrong parameters values, missing values, etc.), the simulation will return the "error" value under "status". The reason of this erroneous status should be explained in the **console** menu, so that the user can easily correct the input file.

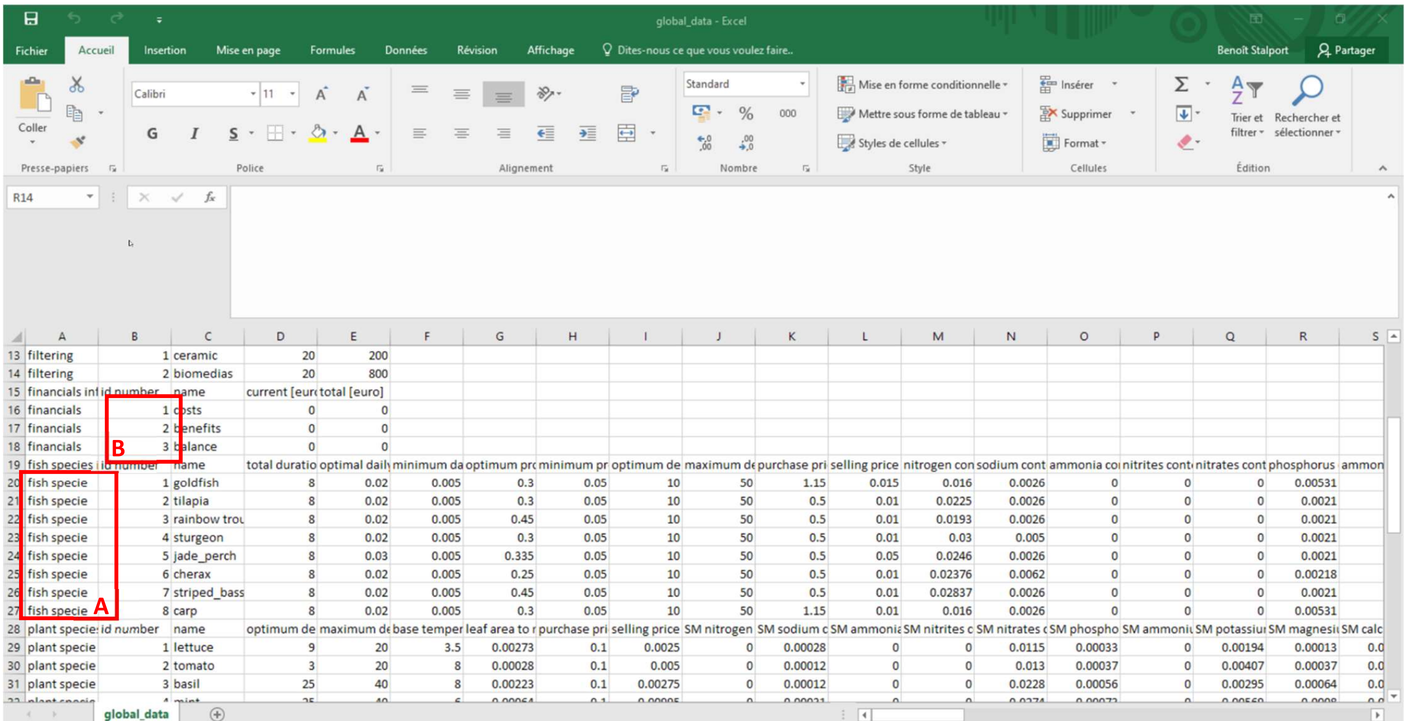
5. Read the Global data file

The file named "*global_data.csv*" is provided to help you build your virtual aquaponic system and as a knowledge database. Global data contains all the data required by the different models (biological development, chemical properties, physical constants, etc.). It is the specific database for parameters values used by the model.

This file is also saved on the server and accessed by the model when running but you do not have access to that particular one in order to avoid unwanted modifications. A good practice when configuring "*user_data.csv*" is to keep both files opened at the same time.

Two columns are important for you to look at in the file:

- **column A**: type of object that specific line refers to (ex: fish specie, bacteria specie, etc.); where one line = one specie
- **column B**: id number of that particular line/specie which you will use when configuring "*user_data.csv*"
- **other columns**: values of the parameters used by the model, found or estimated in the literature or from experiments



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
13	filtering	1	ceramic	20	200														
14	filtering	2	biomedias	20	800														
15	financials inf	id number	name	current [euro	total [euro]														
16	financials	1	costs	0	0														
17	financials	2	benefits	0	0														
18	financials	3	balance	0	0														
19	fish species	id number	name	total duratio	optimal daily	minimum da	optimum prc	minimum pr	optimum de	maximum de	purchase pri	selling price	nitrogen con	sodium cont	ammonia co	nitrites cont	nitrates cont	phosphorus	ammon
20	fish specie	1	goldfish	8	0.02	0.005	0.3	0.05	10	50	1.15	0.015	0.016	0.0026	0	0	0	0.00531	
21	fish specie	2	tilapia	8	0.02	0.005	0.3	0.05	10	50	0.5	0.01	0.0225	0.0026	0	0	0	0.0021	
22	fish specie	3	rainbow trou	8	0.02	0.005	0.45	0.05	10	50	0.5	0.01	0.0193	0.0026	0	0	0	0.0021	
23	fish specie	4	sturgeon	8	0.02	0.005	0.3	0.05	10	50	0.5	0.01	0.03	0.005	0	0	0	0.0021	
24	fish specie	5	jade_perch	8	0.03	0.005	0.335	0.05	10	50	0.5	0.05	0.0246	0.0026	0	0	0	0.0021	
25	fish specie	6	cherax	8	0.02	0.005	0.25	0.05	10	50	0.5	0.01	0.02376	0.0062	0	0	0	0.00218	
26	fish specie	7	striped_bass	8	0.02	0.005	0.45	0.05	10	50	0.5	0.01	0.02837	0.0026	0	0	0	0.0021	
27	fish specie	8	carp	8	0.02	0.005	0.3	0.05	10	50	1.15	0.01	0.016	0.0026	0	0	0	0.00531	
28	plant specie:	id number	name	optimum de	maximum de	base temper	leaf area to r	purchase pri	selling price	SM nitrogen	SM sodium c	SM ammonia	SM nitrites c	SM nitrates c	SM phospho	SM ammoniu	SM potassiu	SM magnesiu	SM calc
29	plant specie	1	lettuce	9	20	3.5	0.00273	0.1	0.0025	0	0.00028	0	0	0.0115	0.00033	0	0.00194	0.00013	0.0
30	plant specie	2	tomato	3	20	8	0.00028	0.1	0.005	0	0.00012	0	0	0.013	0.00037	0	0.00407	0.00037	0.0
31	plant specie	3	basil	25	40	8	0.00223	0.1	0.00275	0	0.00012	0	0	0.0228	0.00056	0	0.00295	0.00064	0.0

Figure 2. *Global data file showing the type of objects (A) and the id number of different types (B)*

6. User data file: presentation and configuration

The file named "*user_data.csv*" is the file that you have to configure with the parameters of your simulation. The organization of the file is very similar to "*global_data.csv*" with column A being the type of object and column B the unique ID number of that object.

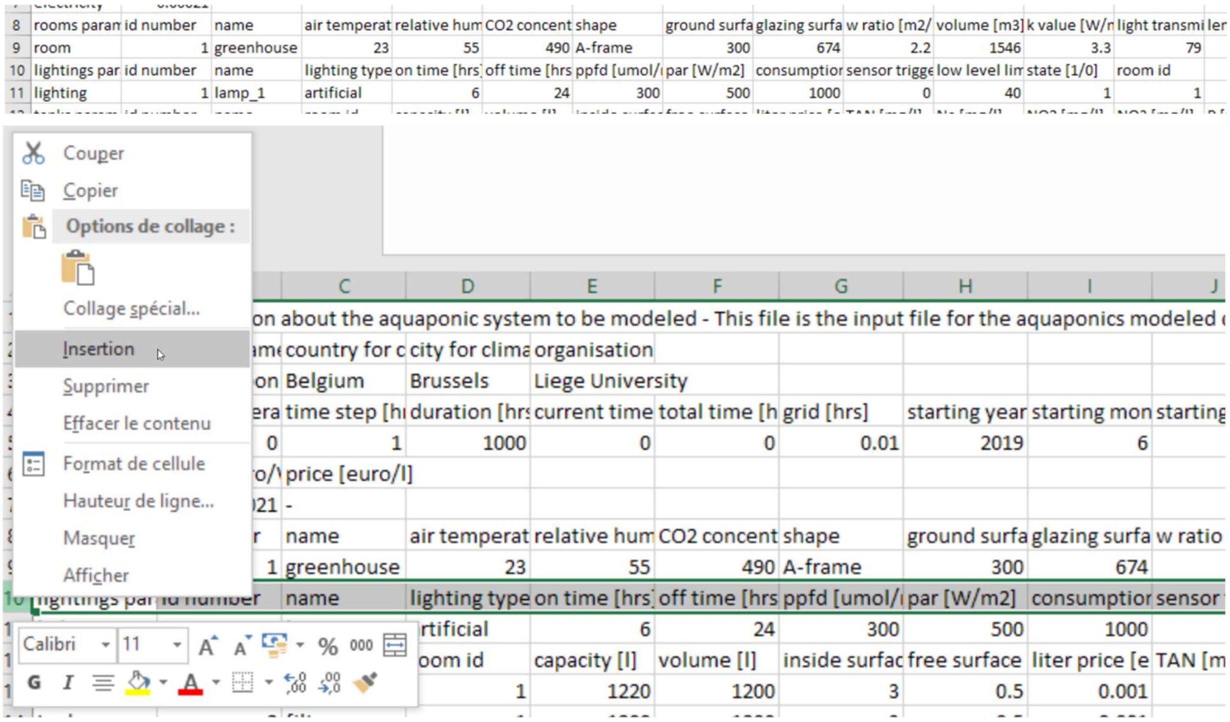
First, you will need to configure the lines #3 and #5 which are not objects that you can duplicate. You simply need to simply adapt the values of the parameters to match your system.

Table 1. *Objects that contain general information needed for the simulation*

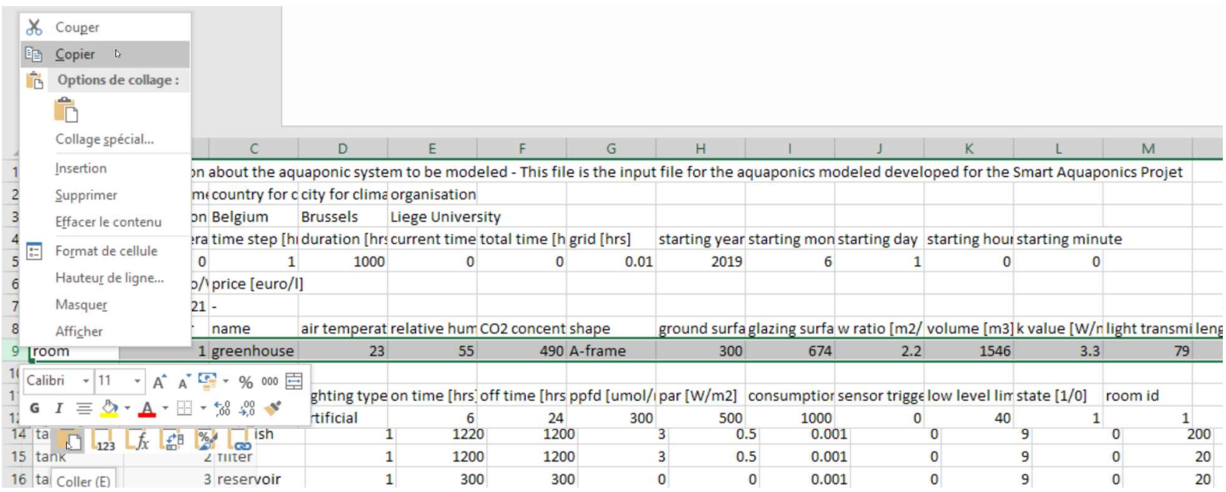
Line #	***Name***	***Description***
3	Information	Contains a few information about your system such as a name for the system, the country and the city, the organization that owns the system, the geographic coordinates of the system (can be found online), the time zone of the system ('Etc/GMT+X') and a boolean parameter (1 or 0) called 'forecast' (if 1: forecast based on weather data for the next 7 days, if 0: simulation of any duration, based on typical weather data)
5	Time parameters	Contains the data that will be used for the simulation, it is important as it defines the simulated time period (change in weather data): contains the simulation time step, the duration, and the starting date and time

To configure the rest of the file, you will have to decompose your simulated aquaponic system as a combination of simple aquaponic objects linked to each other. A good practice is to first draw your aquaponic system on paper before starting the configuration. To add a new object, you need to add a new line with your spreadsheet handler, under the right category. Copy-paste all the parameters values from an existing object, and finally start editing this new object. For instance, here is how to add a room, step-by-step on Microsoft Excel:

1. **Insert new line below the last one of its category**: here, I add a new line at line 10, below the existing first room (line 9)



2. **Copy-paste the values of an existing same-type object**: here I copy the entire line from Room 1 (greenhouse) and I paste it to line 10



3. **Configure your newly created object**: read the names of the parameters and modify your newly created object to match your simulated system (here: id=2; name= aquaculture, etc.)

8	rooms param	id number	name	air temperat	relative hum	CO2 concent	shape	ground surfa	glazing surfa	w ratio [m2/	volume [m3]	k value [W/n	li
9	room	1	greenhouse	23	55	490	A-frame	300	674	2.2	1546	3.3	
10	room	2	Aquaculture	23	55	490	A-frame	300	674	2.2	1546	3.3	
11	lightings par	id number	name	lighting type	on time [hrs	off time [hrs	ppfd [umol/	par [W/m2]	consumptior	sensor trigge	low level lin	state [1/0]	r

The type of objects available to build your system and their description are listed in the following table. Section 8 of this document details the parameters of every possible object. Please refer to that section when configuring your simulation.

Table 2. *Available objects to construct a virtual aquaponic system for simulation*

Object type	***Description***
Room	A room is a generic term used to designate a physical place that can contain other objects. A room can be a greenhouse, an indoor closed space or even an outdoor opened space.
Lighting	The lightings are the lights installed on the systems that use electricity. Each plant can later be associated with one lighting installation. Keep that in mind when creating these objects. For instance, if you have an setup where you use 2 different light intensities, you will need to create two lighting objects.
Tank	The tanks represent anything that can contain some liquid but the pipes. It can be a hydroponic tank, a fish tank, a biofilter, a tank of liquid fertilizer, a storage tank of rain water, a sump, etc. In this tool, sources (ground water, tap water, etc.) are also represented as tanks but with infinite volumes and constant properties.
Pipe	The pipes are the elements that connect the tanks together. They can later be associated with pumps. “Naked” pipes will only transport water due to overflowing volumes
Pump	The pumps are the engines of water circulation in the systems. They have to be associated with a corresponding pipe and can be automated or run continuously.
Electrics	The electrics is a generic category to add any piece of hardware that can not be included in any other categories but consumes enough electricity to be included in the energy balance
Aerator	An aerator is an active system that aims at increasing the amount of dissolved oxygen in the water of a tank
Fish	A fish object is an aquatic animal. It can represent one individual or a group of identical individuals and the specie can be chosen from the “*global_data.csv*” file
Plant	A plant object is any plant of the system. It can represent one individual or a group of identical individuals. It can be fruity or leafy and the specie can be chosen from the “*global_data.csv*” file
Feeding	The feedings are times at which a particular kind of feed is added to a tank
Event	Events objects are used to define times at which the value of any tank or room parameters will suddenly change. This is useful to simulate an abrupt change of conditions and study the reaction of the system (system crashes, pH drops, fail of automation, etc.)

7. Results: graphs and comprehensive text file

The website provides you with two types of results. Figures that are directly displayed and that can be downloaded and a downloadable output file in the form of text file, "*results.txt*". Some figures are generated automatically based on what users usually find most interesting. Because of that, you will not find graphs for every simulated parameter.

However, all the computed values are stored in the comprehensive text file ("*results.txt*"). The first column is an increment on the stored parameters, the second column holds the name of the parameter stored on that line and the other columns are the evolution of the value of the parameter during the simulated experiment. In time, the values evolve per user-defined time-step between columns. That file can easily be imported in any data handler to make personalized graphs if needed.

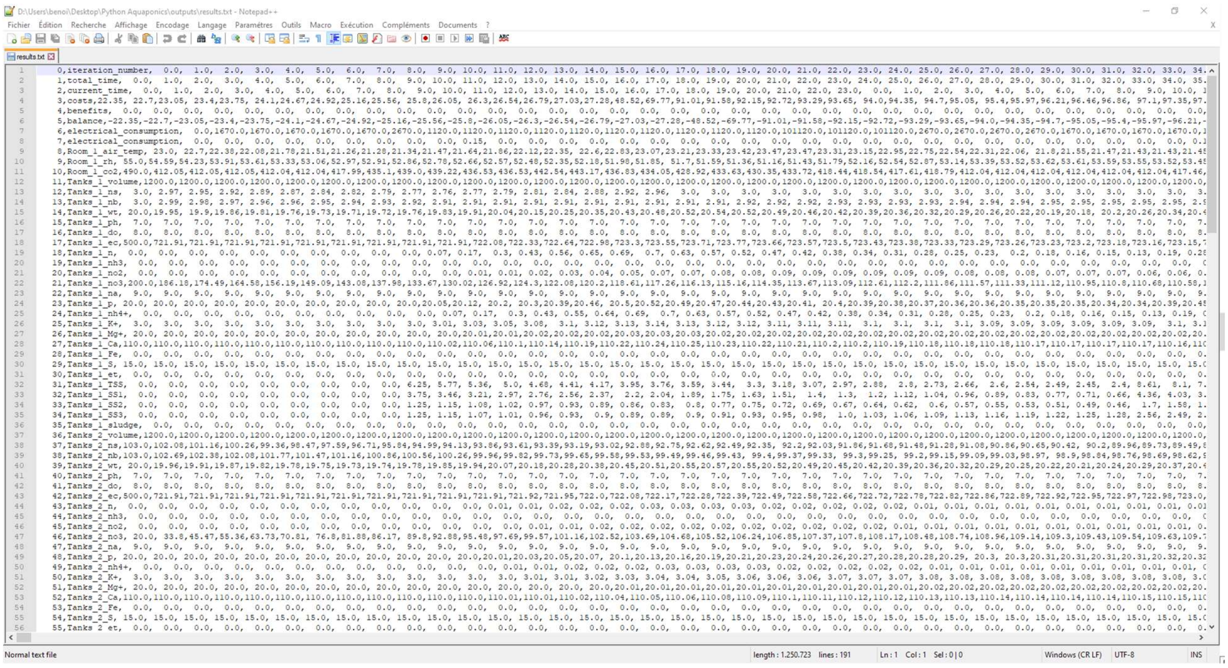


Figure 3. *Example of "results.txt" showing the evolution of the stored values for different parameters of every objects*

8. Detailed objects parameters

a. Information

PARAMETER'S NAME	DEFINITION	FREE CHOICE	POSSIBLE VALUES
System's name	Name of the system	v	Anything
Country	Country of location	v	Anything
City	City of location	v	Anything
Organization	Name of the owner's	v	Anything
Latitude	Geographic latitude of the system	v	-90° to 90°
Longitude	Geographic longitude of the system	v	-180° to 180°
Time zone	Time zone of the system	v	'Etc/GMT+X' where X must be adapted [-12 to +12]
Forecast	Boolean parameter to choose between the 7-days forecasting mode (1) or the typical weather data *'TMY'* mode (0)	v	0 or 1

b. Time parameters

PARAMETER'S NAME	DEFINITION	FREE CHOICE	POSSIBLE VALUES
Time step	Time step used for the numerical resolution	× / v	Best left to 1 (most optimal)
Duration	Total duration of simulation	v	1 → ∞
Starting year	Starting year of simulation (used in TMY)	v	Any year
Starting month	Starting month of simulation (used in TMY)	v	1 → 12
Starting day	Starting day of simulation (used in TMY)	v	1 → 31
Starting hour	Starting hour of simulation (used in TMY)	v	0 → 23

c. Prices

PARAMETER'S NAME	UNIT	DEFINITION	FREE CHOICE	POSSIBLE VALUES
Price	€/Wh	Price paid for a Wh of electricity during the simulation	v	0 → ∞

d. Rooms

PARAMETER'S NAME	UNIT	DEFINITION	FREE CHOICE	POSSIBLE VALUES
ID number	-	Unique number of identification	v	1 → total number of rooms (each must be used)
Name	-	Name of the room	v	Anything
Unit price	€	Price of the room	v	0 → ∞
Width	m	Width of the room	v	1 → ∞
Length	m	Length of the room	v	1 → ∞
Average height	m	Average height of the room	v	1 → ∞
Glazing surface	m²	Total surface of walls + roofs	v	1 → ∞
k value	W/m².°C	Thermal conductivity of the walls material	v	0 → ∞
Light transmissivity	%	Light transmissivity of the walls material	v	0 → 100
Initial air temperature	°C	Initial air temperature of the room	v	-50 → 100
Initial relative humidity	%	Initial RH of the room	v	0 → 100
Initial CO2 concentration	ppm	Initial [CO2] of the room	v	0 → 5000
Day time	hrs	Start of the day time for the regulations	v	0 → 23
Night time	hrs	Start of the night time for the regulations	v	0 → 23
Day temperature low limit	°C	Lowest temperature wanted during the day		0 → 100
Day temperature high limit	°C	Highest temperature wanted during the day	v	0 → 100
Night temperature low limit	°C	Lowest temperature wanted during the night	v	0 → 100
Night temperature high limit	°C	Highest temperature wanted during the night	v	0 → 100
Vents	-	Does the room have any vents?	v	1/0
Vents total surface	m²	Total exchange surface of the vents	v	0 → ∞
N fan	-	Number of fans of the room (for outside exchanges)	v	0 → ∞
Fan air flow rate	m³/hrs	Air flow rate of one active fan	v	0 → ∞
Fan consumption	W	Electrical consumption of one fan	v	0 → ∞
Fan continuously on	-	Is the fan continuously on?	v	1/0
Shadings	-	Presence or absence of shadings	v	1/0
Active or passive shadings	active [1] or passive [0]	Active or passive shadings	v	1/0
Shadings transmittance	%	Shadings transmittance	v	0 → 100
Shadings absorbance	%	Shadings absorbance	v	0 → 100
N heaters	-	Number of heaters in the room	v	0 → ∞
Heater consumption	W	Electrical consumption of one heater	v	0 → ∞
Heater efficiency	%	Efficiency of one heater	v	0 → 100
N coolers	-	Number of coolers in the room	v	0 → ∞
Coolers consumption	W	Electrical consumption of one cooler	v	0 → ∞
Coolers cooling capacity	W	Cooling capacity of one cooler	v	0 → ∞
CO2 complementation	-	Is the room complemented in CO2?	v	1/0
CO2 on time	hrs	Time when the complementation turns on	v	0 → 23
CO2 off time	hrs	Time when the complementation turns off	v	0 → 23
Low level limit	ppm	Lowest wanted CO2 levels	v	0 → ∞
High level limit	ppm	highest wanted CO2 levels	v	0 → ∞
Flow rate	m³/hrs	CO2 flow rate of the complementation system	v	0 → ∞
Price	€/m³	Unit price of the CO2	v	0 → ∞
Sealed	-	Is the room completely sealed? (No natural air exchanges)	v	1/0
Outdoor	-	Is the room an opened outdoor space?	v	1/0
Indoor	-	Is the room an indoor room?	v	1/0
Greenhouse	-	Is the room a greenhouse?	v	1/0

e. Lightings

PARAMETER'S NAME	UNIT	DEFINITION	FREE CHOICE	POSSIBLE VALUES
ID number	-	Unique number of identification	v	1 → total number of lightings (each must be used)
Name	-	Name of the lighting system	v	Anything
Unit price	€	Price of the lighting unit	v	0 → ∞
On time	hrs	Time at which the system turns on	v	0 → 23
Off time	hrs	Time at which the system turns off	v	0 → 23
PPFD	µmol/m².s	PPFD generated by the system at the plant base	v	0 → ∞
PAR	W/m²	PAR generated by the system at the plant base	v	0 → ∞
Consumption	W	Electric consumption of the system	v	0 → ∞
Sensor triggered	-	System automated with a light sensor	v	1/0
Low level limit	µmol/m².s	Natural light PPFD limit under which the lights turn on (and off if higher), still respects the times limits	v	0 → ∞
State	-	Current state of the system (on/off = 1/0) at the beginning of the simulation	v	1/0
Room ID	-	ID of the room where the system is installed	v	1 → total number of rooms

f. Tanks

PARAMETER'S NAME	UNIT	DEFINITION	FREE CHOICE	POSSIBLE VALUES
ID number	-	Unique number of identification	v	1 → total number of tanks (each must be used)
Name	-	Name of the tank	v	Anything
Unit price	€	Price of the tank unit	v	0 → ∞
Room ID	room id	ID of the room where the tank is located	v	1 → total number of rooms
Capacity	l	Maximum volume of the tank before overflowing occurs	v	1 → ∞
Volume	l	Volume of water in the tank at the start of simulation	v	1 → ∞
Cultivation surface	m²	Available surface for plants cultivation	v	0 → ∞
Inside surface	m²	Total inside surface of the tanks (in contact with water)	v	0 → ∞
Free surface	m²	Free surface of the tanks (0 if closed container)	v	0 → ∞
Irradiated surface	m²	Surface of water that receives direct lighting	v	0 → ∞
Liter price	€/l	Unit price of the liquid inside the tank	v	0 → ∞
N-TAN	mg/l	Initial concentration of N-TAN	v	0 → ∞
Na	mg/l	Initial concentration of Na	v	0 → ∞
N-NO2	mg/l	Initial concentration of N-NO2	v	0 → ∞
N-NO3	mg/l	Initial concentration of N-NO3	v	0 → ∞
P	mg/l	Initial concentration of P	v	0 → ∞
K	mg/l	Initial concentration of K	v	0 → ∞
Mg	mg/l	Initial concentration of Mg	v	0 → ∞
Ca	mg/l	Initial concentration of Ca	v	0 → ∞
Fe	mg/l	Initial concentration of Fe	v	0 → ∞
S	mg/l	Initial concentration of S	v	0 → ∞
EC	µS/cm	Initial EC	v	0 → ∞
DO	mg/l	Initial DO	v	0 → ∞
pH	-	Initial pH (stays stable, not modeled)	v	0 → 14
Water temperature	°C	Initial water temperature	v	0 → 100
Conditions type	-	Development conditions [0 = hydroponics, 1 = aquaponics, 2 = Not-Defined]	v	0, 1 or 2

Cycling state	-	Initial cycling state of the tank (1= biofilm fully developed, 0= new system with no bacterial activity)	v	0 → 1
Optimal bacterial growth	-	Do the bacteria grow optimally at all times, regardless of the environmental conditions?	v	1/0
Filtering tank	-	Is the tank specialized in filtering (physical or biological)?	v	1/0
Filtration material ID	-	ID of the filtering media inside the tank	v	1 → total number of filtration material (< "*global_data.csv*"), 0 if none
Filtration material quantity	m³	Quantity of filtering media	v	0 → tank volume
Particles removing S1	-	Proportion of big particles removed	v	0 → 1
Particles removing S2	-	Proportion of medium particles removed	v	0 → 1
Particles removing S3	-	Proportion of small particles removed	v	0 → 1
Particles transforming S1	-	Proportion of big particles broken up	v	0 → 1
Particles transforming S2	-	Proportion of medium particles broken up	v	0 → 1
Source	-	Is the tank a source? (Constant properties and volume)	v	1/0
N heaters	-	Number of heaters in the water	v	0 → ∞
Heater consumption	W	Electrical consumption of one heater	v	0 → ∞
N coolers	-	Number of coolers in the water	v	0 → ∞
Coolers consumption	W	Electrical consumption of one cooler	v	0 → ∞
Coolers cooling capacity	W	Cooling capacity of one cooler	v	0 → ∞
Minimum temperature	°C	Minimum temperature wanted in the tank	v	0 → 100
Maximum temperature	°C	Maximum temperature wanted in the tank	v	0 → 100
Denitrification rate	ppm/hrs	Denitrification rate occurring in the tank	× / v	0.01 → ∞ (0.01 is the naturally occurring rate)
UV treated	-	Is the tank treated with UV, or the water coming in?	v	1/0

g. Pipes

PARAMETER'S NAME	UNIT	DEFINITION	FREE CHOICE	POSSIBLE VALUES
ID number	-	Unique number of identification	v	1 → total number of pipes (each must be used)
Unit price	€	Price of the pipe unit	v	0 → ∞
From tank ID	-	ID of the tanks from which the water comes	v	1 → total number of tanks
To tank ID	-	ID of the tanks to which the water goes	v	1 → total number of tanks
Pump ID	-	ID of the pump to which it is associated	v	0 (if no pump) or 1 → total number of pumps

h. Pumps

PARAMETER'S NAME	UNIT	DEFINITION	FREE CHOICE	POSSIBLE VALUES
ID number	-	Unique number of identification	v	1 → total number of pumps (each must be used)
Unit price	€	Price of the pump unit	v	0 → ∞
Pipe ID	-	ID of the associated pipe	v	1 → total number of pipes
Flow rate	l/hrs	Flow rate of the pump	v	0 → ∞
Consumption	W	Electrical consumption of the pump	v	0 → ∞
Regulated	-	Is the pump automated based on a measured value?	v	1/0
Regulation parameter	-	Parameter used for the regulation	v	"level" or "ec"
Measured uptank/downtank	-	Place of measurement for regulation	v	"downtank" or "uptank"
Minimum value	l or µS/cm	Minimum value for activation of the pump	v	0 → ∞
Maximum value	l or µS/cm	Maximum value for deactivation of the pump	v	0 → ∞
Active time slots	-	Number of active time slots	v	0 → 5
On time X	hrs	On time for time slot #X	v	0 → 23
Off time X	hrs	Off time for time slot #X	v	0 → 23

i. Electrics

PARAMETER'S NAME	UNIT	DEFINITION	FREE CHOICE	POSSIBLE VALUES
ID number	-	Unique number of identification	v	1 → total number of electrics (each must be used)
Unit price	€	Price of the electrical unit	v	0 → ∞
Name	-	Name of the electrical system	v	Anything
Room ID	-	ID of the room where the system is located	v	1 → total number of rooms
Tank ID	-	ID of the tank to which the system is associated	v	1 → total number of tank
Consumption	W	Electrical consumption of the system	v	0 → ∞
Continuous	-	Is the system continuously on?	v	1/0
On time	hrs	Time at which the system turns on	v	0 → 23
Off time	hrs	Time at which the system turns off	v	0 → 23

j. Aerators

PARAMETER'S NAME	UNIT	DEFINITION	FREE CHOICE	POSSIBLE VALUES
ID number	-	Unique number of identification	v	1 → total number of electrics (each must be used)
Unit price	€	Price of the aerator unit	v	0 → ∞
Tank ID	-	ID of the tank to which the aerator is associated	v	1 → total number of tank
Consumption	W	Electrical consumption of the aerator	v	0 → ∞
Continuous	-	Is the system continuously on?	v	1/0
On time	hrs	Time at which the system turns on	v	0 → 23
Off time	hrs	Time at which the system turns off	v	0 → 23
Pure oxygen	-	Is it an injection of pure O2 ?	v	1/0
O2 price	€/m³	Unit price of the pure O2	v	0 → ∞
Flowrate	l/hrs	Flowrate of the aerator	v	0 → ∞
Absorption efficiency	%	Absorption efficiency of the system	v	0 → 100

k. Fish

PARAMETER'S NAME	UNIT	DEFINITION	FREE CHOICE	POSSIBLE VALUES
ID number	-	Unique number of identification	v	1 → total number of fish (each must be used)
Buying price	€/fish	Buying price of one fish	v	0 → ∞
Selling price	€/g	Selling price of one gram of fish	v	0 → ∞
Specie ID	-	ID of the specie of the fish	v	1 → total number of fish species (< "*global_data.csv*")
Tank ID	-	ID of the tank in which the fish is located	v	1 → total number of tanks
Age	hrs	Initial age of the fish	v	0 → ∞
Automatic calculation	-	Automatic initial mass and length calculation based on the initial age of the fish only	v	1/0
Mass	g	Initial mass of the fish	v	0 → ∞
Length	mm	Initial length of the fish	v	0 → ∞
Inserting time	hrs	Time at which the fish will be introduced in the system	v	0 → ∞
Number of identical individuals	-	Number of identical individuals in this population	v	1 → ∞
Selling mass	g	Fish mass at which automatic selling will occur	v	0 → ∞
Selling age	hrs	Fish age at which automatic selling will occur	v	0 → ∞
Optimal growth	-	Do the fish grow optimally at all times, regardless of the environmental conditions?	v	1/0

l. Plants

PARAMETER'S NAME	UNIT	DEFINITION	FREE CHOICE	POSSIBLE VALUES
ID number	-	Unique number of identification	v	1 → total number of plants (each must be used)
Buying price	€/seed	Buying price of one seed or seedling	v	0 → ∞
Selling price	€/g	Selling price of one gram of plant (leafy) or fruits (fruity)	v	0 → ∞
Specie ID	-	ID of the specie of the plant	v	1 → total number of plant species (< "*global_data.csv*")
Tank ID	-	ID of the tank in which the plant is located	v	1 → total number of tanks
Cultural component ID	-	ID of the cultural component	v	1 → total number of cultural component (< "*global_data.csv*")
Planting time	hrs	Time at which the plant will be planted in the system	v	0 → ∞
Age	hrs	Initial age of the plant	v	0 → ∞
Automatic calculation	-	Automatic initial parameters calculation based on the initial age of the plant only (DD, LA, PM, FM)	v	1/0
Day degrees	°C	Initial day degrees sum of the plant	v	0 → ∞
Leaf area	m²	Initial leaf area of the plant	v	0 → ∞
Plant mass	g	Initial structural plant mass of the plant	v	0 → ∞
Fruit mass	g	Initial fruit mass of the plant	v	0 → ∞
Lighting ID	-	ID of the lighting system to which the plant is associated	v	0 (if no light) or 1 → total number of lightings
Number of identical individuals	-	Number of identical individuals to this one	v	0 → ∞
Selling mass	g	Reached unit mass at which automatic selling will occur (total mass for leafy and fruit mass for fruity)	v	0 → ∞
Selling age	hrs	Plant age at which automatic selling will occur	v	0 → ∞
Optimal growth	-	Do the plants grow optimally at all times, regardless of the environmental conditions?	v	1/0

m. Feedings

PARAMETER'S NAME	UNIT	DEFINITION	FREE CHOICE	POSSIBLE VALUES
ID number	-	Unique number of identification	v	1 → total number of feedings (each must be used)
Name	-	Name of the feeding	v	Anything
Feed ID	-	ID of the given feed	v	1 → total number of feed (< "*global_data.csv*")
Unit price	€/g	Unit price of the given feed	v	0 → ∞
Tank ID	-	ID of the tank where the feeding occurs	v	1 → total number of tanks
Feeding time	hrs	Time of the day when the feeding occurs	v	0 → 23
Quantity	g	Quantity of feed given (if not adapted to mass)	v	0 → ∞
Adapted to fish mass	-	Is the feeding a percentage of fish mass?	v	1/0
Mass percentage	%	Percentage of total fish mass given as feed	v	0 → 100
Continuous feeding	-	Does it occur during the entire simulation?	v	1/0
Starting time	hrs	If not continuous, when does it start?	v	0 → ∞
End time	hrs	If not continuous, when does it end?	v	0 → ∞

n. Events

PARAMETER'S NAME	UNIT	DEFINITION	FREE CHOICE	POSSIBLE VALUES
ID number	-	Unique number of identification	v	1 → total number of events (each must be used)
Name	-	Name of the event	v	Anything
Concerned object	-	Type of object affected by the event	v	'fish', 'plant', 'room' or 'tank'
Object ID number	-	ID of the object affected by the event	v	1 → total number of that object type
Affected parameter	-	Any parameter that the affected object possesses. This parameter must respect the underlying Python code formalism	v	Works with most parameters such as: ph, do, ec, water_temperature, cycling_state, ns_occupation, nb_occupation, uv_treated, air_temperature, relative_humidity, CO2_conc, k_value, light_transmissivity, state, in_system, number_of_individuals, etc.
New value	variable	New value for the parameter	v	? → ?
Event time	hrs	Time at which the parameter takes that new value	v	0 → 23