ICEtool v1.0
User manual #EN

https://github.com/Art-Ev/ICEtool

*If **ICEtool** is based on a set of physical phenomena put into equations, the result remains an **estimate**. As some phenomena are simplified and others are not taken into account (for the moment), An analysis performed with ICEtool cannot replace a real model performed with specialized tools or software (e.g. envi-met). Finally, ICEtool is intended to be used up to neighborhood scale. It should not be used beyond that scale, for example at the city level (the influence of some physical phenomena not considered in the calculation would then become too important at this scale).*

In case of difficulties, an example project gathering all the files and information necessary to carry out the different procedures and visualizations is provided. To access it, use the "Generate an example project" function in the "Help" section of ICEtool.

STEP_0:

Study location choice:

- Already identified project
- dentification of a high-stakes area, for example from satellite data such as LST (Land Surface Temperature) that can be cross-referenced with data describing the affected population.

Check that the QGIS processing toolbox panel is active (CTRL-ALT-T) and that ICEtool processing procedures are available.

STEP_1: Project creation and setup

1. Generate the project folder by indicating its location and then open it.
2. Fill in the various files contained in the "Step_1" folder of the project folder created:

   a. **WeatherData.csv** : fill this file with weather data of the studied site or place an **.epw file** in the **Step_1** folder (epw is a standard format describing weather data).

   An epw file can be generated by a software like Meteonorm or downloaded from platforms like :

   - https://climate.onebuilding.org/default.html
   - https://www.ladybug.tools/epwmap/
   - https://energyplus.net/weather

   b. Use the QGIS project file (.qgz) at the root of the project folder to complete the following layers (these are stored in the **Project_data.gpkg** file in the **Step_1** folder):

   - **Study_area** : polygon describing the **total area** of the study site
   - **Buildings** : polygons describing **buildings** in the area (if a default value can be applied, it is strongly recommended to fill in the building height field). In France, this information can for example be retrieved directly from the **cadastre** or from the **BD Topo** provided by the **IGN**. In the same way, in case of a green roof, it's recommended to fill the information concerning the substrate thickness, and the number of plant stratas.
   - **Trees** : point layer describing the location of **vegetation**, its radius and height (or polygon layer with height field)

- **Ground** : description of **ground materials**. Create non-overlapping polygons (e.g. by activating the non-overlapping option integrated in QGIS, tutorial here). Fill in the material code, the presence of trees in the area, and the other information if the material chosen is a plant material (fully natural area, the substrate thickness, and the number of plant strata), giving better results on CBSh. The material properties should automatically appear in the layer table (imported from the **Material_database.csv** file in the **Step_1** folder). Use one of the fixed-temperature materials to model, for example, a fountain with constantly renewed water.

Optional: add new materials and adjust coefficients by modifying **Material_database.csv** file in **Step_1** folder.

- **Lights** : point layer describing the public lightning. This layer only has a visual purpose for now, it won't be used for the following steps. It is recommended to disable the other layers («Trees» and «Ground») for optimal rendering. Fill the information: the height (in meters), power (in lumens), and optionally the angle (in degrees) of the lighting, the bulb temperature (in kelvin), as well as the minimum illuminance from which the area is viewed in darkness (in lux).

Caution: If you create these layers yourself instead of filling in the ones provided (e.g. to work on projects outside mainland France), remember to check that you are using the correct coordinate system and that it is the same for all your layers. (The use of a projected SCR is mandatory to use ICEtool)

STEP_2: Preparing for shadows generation

UMEP shadow generator requires in our case the use of at least 2 raster files:

- A file describing both the ground level and buildings heights
- A file describing the shape of the vegetation

To generate these files with **ICEtool**, two possibilities :

1. **Create rasters (tree points)** procedure, in case vegetation description has been done with a point layer.
2. **Create rasters (tree poly)** procedure, in case vegetation description has been done with a polygon layer.

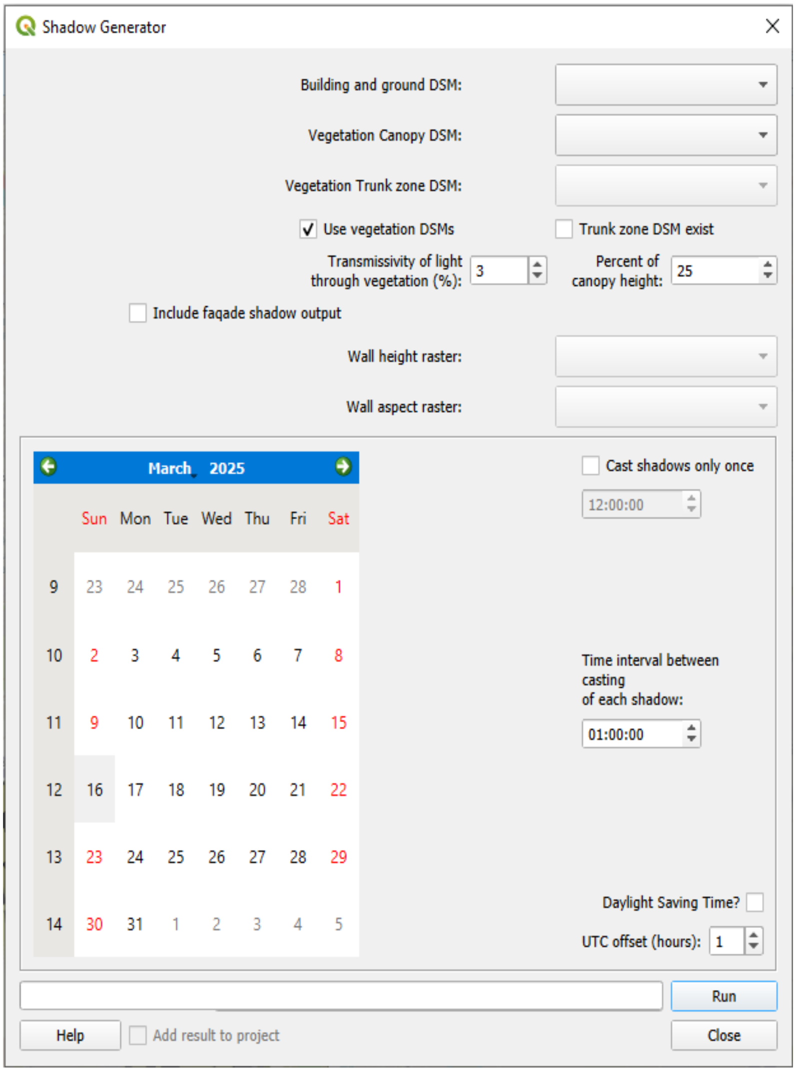
In both cases, procedure parameters are pre-filled (layers & default values to be used) except for the study site's area, which still needs to be filled in. It's possible to adjust these parameters manually.

BuildingTerrain_raster.tif & **Tree_raster.tif** files are automatically created in the **Step_2** folder of the project directory. **Add them to your QGIS project to continue.**

Advanced users: you can also generate these rasters yourself, for example to include information from a digital terrain model.

STEP 3: Calculating shadows with UMEP shadow generator

To compute shadows, [UMEP](#)shadow generator has been included directly into ICEtool. Launching Step_3 function should display a menu like this:



Fill in the parameters:

- **Building and ground DSM**: **BuildingTerrain_raster.tif** (**Step_2** folder)
- **Vegetation Canopy DSM** : **Tree_raster.tif** (**Step_2** folder)
- **Transmissivity of light through vegetation** (default 3%): transparency of vegetation, to be adjusted for example to model deciduous trees after autumn
- **Widget Calendar**: Select the desired study date
- **Time interval** : 1h
- **UTC offset** : 1 if in France for instance
- **Add result to project** : unchecked to avoid overloading QGIS project

Generated files describe the shadows throughout the day (hour by hour).

STEP_4: Calculation of temperatures throughout the day

To calculate temperatures throughout the day, use one of the two procedures in step 4 (weather data from csv or from an epw file).

- **Enter the month and day of the desired analysis**
- **Check that the buildings and ground layers are correctly filled in**
- **Check that the paths to the ETP.csv and weather data files are correct**
- **Spatial accuracy (advanced parameter, default=1.0) :** parameter describing the spatial accuracy of the calculation, decrease to speed up the calculation, increase to increase spatial accuracy.

Other necessary files will be automatically retrieved from the various **Step** folders.

calculation time may vary depending on your computer, using the default settings for the example project should give a calculation time of less than 5min (approx. 2min30 on the computers used during development).

Result will automatically be saved in a csv file in the **Step_4** folder and loaded into QGIS with a preconfigured symbology of the maximum temperatures observed on study day.

Loaded layer contains the following fields:

- **min_DegC :** minimum temperature observed during the day (in degrees Celsius)
- **mean_DegC :** average temperature observed during the day (in degrees Celsius)
- **max_DegC :** maximum temperature observed during the day (in degrees Celsius)
- **Temp_DegC** : contains a list describing ground temperatures throughout the day

Analysis of results :

Resulting layer allows for each configuration tested to create comparative visuals or to obtain key comparison indicators.

For example: with QGIS Group Stats tool (equivalent to Microsoft Excel pivot tables), it is possible in a few clicks to calculate for a scenario: the average, median and maximum of the warmest temperatures observed in the study area.

	1	2	3	4
1	Fonction	maximum	moyenne	médiane
2		50,54	35,3503	34,89

Once « Ground », « Trees » & « Buildings » layers are completed, several indicators are dynamically calculated:

- **CR :** « Coefficient de ruissèlement » is the Runoff Coefficient
- **CBSh :** « Coefficient de Biotope de Surface harmonisé » , based on the work of Berlin City. This indicator has been modified and is now using the definition provided by the CSTB (description Here) . Final result is between 0 and 1.
- **Artificial :** % of ground artificialization
- **Mean of daily max temps**