WILIAM
User guide

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Summary

This document explains how to run WILIAM in Vensim software for 2 cases: (1) using the freeware Vensim Model Reader (which allows to run a published version with some limitations), and (2) using the full software Vensim DSS (proprietary) which allows full transparency and flexibility. Both options include an Excel file which operates as an interface that allows, to those users not familiar with Vensim, to design and run their own scenarios.

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1. Introduction

You are about to download WILIAM, under Licence MIT. This version is not a fully validated model and hence it is not possible to use the whole model with confidence. The core developer team will continue developing the model and release updates in the close future. If you have any comment, question or detect any bug, please report them to info.wiliam@uva.es.

This User's Guide explains the basic software requirements and knowledge for any user to be able to run the WILIAM model with both the freeware Vensim Model Reader and the proprietary software Vensim DSS. These two versions present the following differences.

In the case of Vensim Model Reader, the user is not allowed to make changes in the structure of the model (the equations are not visible[1] and cannot be modified). However, the user can change the scenario inputs through the input data file "**scenario_parameters.xlsx**". All the model parameters are also available in editable excel files.

Users of the Vensim DSS version can modify the structure as well as the equations from the software.

As the minimum software recommendations, the user should know that, for the Vensim DSS, WILIAM typically uses ~20 Gb of RAM memory, hence it is recommended 32 Gb. In the case of Vensim Model Reader, this version is much less intensive than the DSS, so 16 Gb would be well enough.

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[1] Equations can be viewed in \wiliam\Documentation&ToDo\equation_documentation_WILIAM_(version).pdf

2. Download Vensim

2.1. Vensim Model Reader

To open the "vpm." extension file it is necessary to install the freeware Vensim Model Reader noted in the previous epigraph. Follow instructions and download it here: http://vensim.com/vensim-model-reader/.

2.2. Vensim DSS

To open the "mdl." extension file it is necessary to install the proprietary software Vensim Model Reader noted in the previous epigraph. Follow instructions and download it here: https://vensim.com/php-bin/download.html

3. Installation of Vensim Model Reader and DSS

When opening the software, after the installation, a short tutorial will appear (Figure 1).

For beginners who use the freeware Vensim Model Reader, it is recommended to follow this tutorial to learn the basics (e.g. represent a result in a graph) and get familiar with the tool:
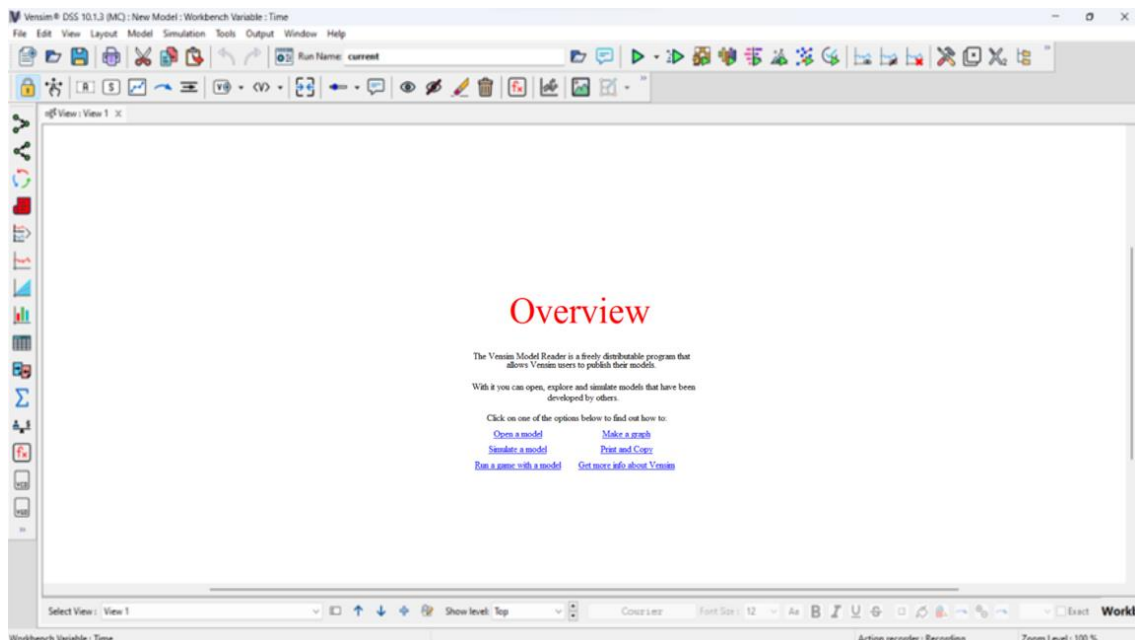

Figure 1. Vensim overview.

4. Download model and associated files

When downloading and uncompressing the file WILIAM.zip, the following files can be found (Figure 2):

📁 Documentation&ToDo	01/12/2023 9:18	Carpeta de archivos	
📁 model_parameters	01/12/2023 9:19	Carpeta de archivos	
📁 scenario_parameters	01/12/2023 9:19	Carpeta de archivos	
📕 changes v1.2 vs 1.1.pdf	01/12/2023 9:18	Documento Adob...	118 KB
📄 licence.txt	01/12/2023 9:18	Documento de tex...	3 KB
Ⓥ WILIAM.mdl	01/12/2023 9:19	Vensim model (M...	10.572 KB
Ⓥ WILIAM.vpmx	01/12/2023 9:19	Vensim packaged ...	1.301.762 ...

Figure 2. Files inside WILIAM.zip

- **Documentation&To-DO folder**: in this folder there is one folder for each module with general documentation, like the description of indexes. There is also information related to the programming norms, model diagrams and other relevant bibliography about the model.
- **model_parameters folder**: here the user can find 9 folders, one for each module, which contain an Excel file where the module parameters are saved.
- **scenario_parameters folder**: it contains the following files:
  - **scenario_parameters.xlsx**[2] stores the input data required for running the by-default scenario and creating new ones. This file includes a tab named "ReadMe", which contains an explanation of its structure. Here the user can find detailed information about the modules that organise the model, the variables that can be modified, and useful definitions of concepts, like policies and hypotheses, that will guide the user to create scenarios. A detailed description of this file will be explained in the coming pages.
  - **switches.xlsx:** this excel includes the module and inter-module links SWITCHES from WILIAM, as well as information on how to simulate the model with (dis)connected features. SWITCHES in WILIAM refer to binary parameters which can hence take just two values (0/1) and which mean connect/disconnect. Inside the .xlsx file the user can find more information about it and some instructions of use in tab named "Info".

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[2] Additional software requirements: A version of Microsoft Excel allowing to work with tabs.

> **IMPORTANT**
>
> Do not modify the name of the excel files neither those of the tabs since the paths defined in Vensim are fixed.

- **changes v1.2 vs 1.1.pdf**: this document includes the main changes introduced in the WILIAM Vensim version by module with relation to the previous release. In this case it is being compared 1.1 version to 1.2 version.
- **Licence.txt**: MIT licence
- **WILIAM.vpmx** allows to open, explore and simulate the model with the freeware Vensim Model Reader.
- **WILIAM.mdl** is the full model programmed in Vensim, which allows to open, explore, simulate and modify the structure of the model. To open and work with this file, the proprietary software Vensim DSS version or superior is required (http://www.vensim.com).

5. Open Model

Once the software is installed and the short tutorial completed, open the model by clicking on WILIAM.vpmx or WILIAM.mdl an introduction view should appear (Figure 3).

Figure 3 introduction view
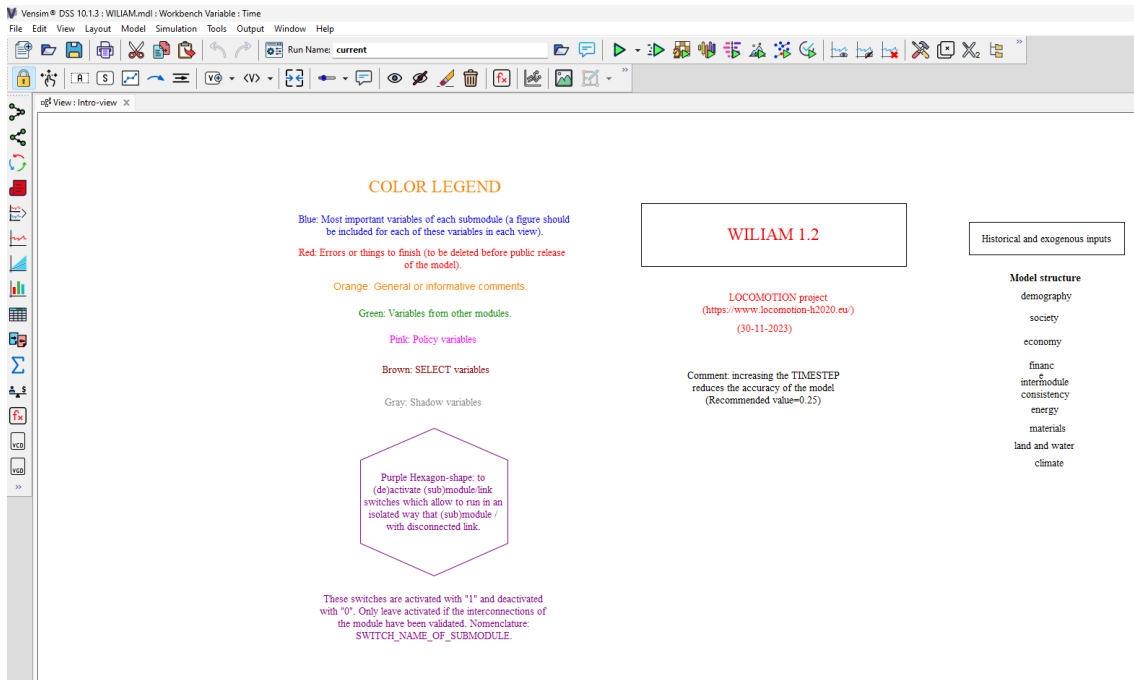
WILIAM has been developed with a modular structure, and the programming in Vensim is structured in different views (Figure 4). Each Vensim view name should indicate the module, category and subcategory to which the variables represented there belong. The structure will be "module-category-name_of_the_view", with "name_of_the_view" corresponding to the subcategory, e.g., energy-electricity_demand. This standard is consistent with the naming of the data input .xlsx files and will also help systematizing the classification of information in the data dictionary.
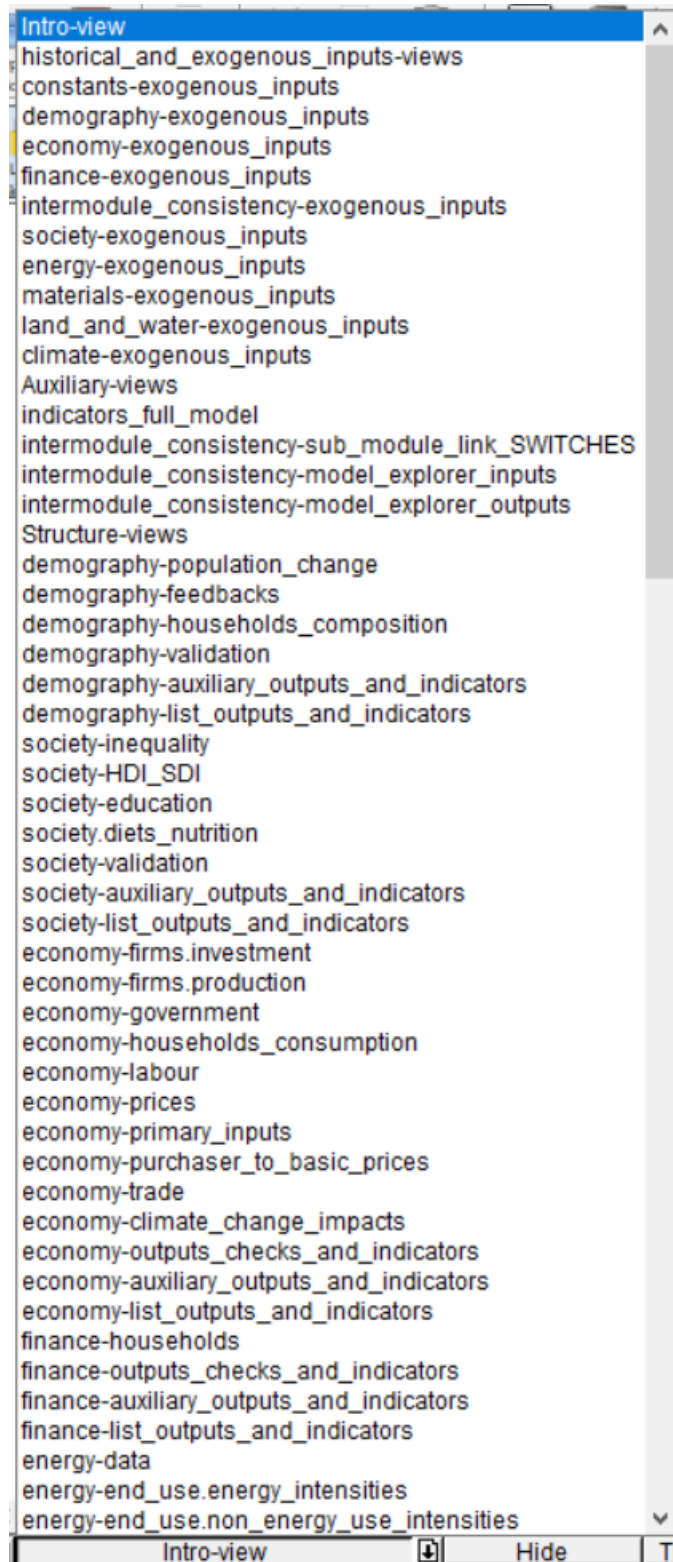
Figure 4. List of the first part of WILIAM views in Vensim.

As the user can see, WILIAM has over 100 views, so they follow a determined structure ordered by modules:

- Intro
- historical_and_exogenous_inputs-views
- Auxiliary views
  - SWITCHES: to (de)activate modules, submodules and links.
  - Model Explorer inputs and outputs
- Structure views
  - Module-list_outputs_and_indicators

At the bottom of the screen, you find a few buttons (Figure 5) They let you change the view:

1. Use the "Page up" and "Page down" arrow to move one by one through the model.

Figure 5. Change the view one by one.

2. Click in the dropdown menu "Select view" to move to another view you want to display. (Figure 6.)
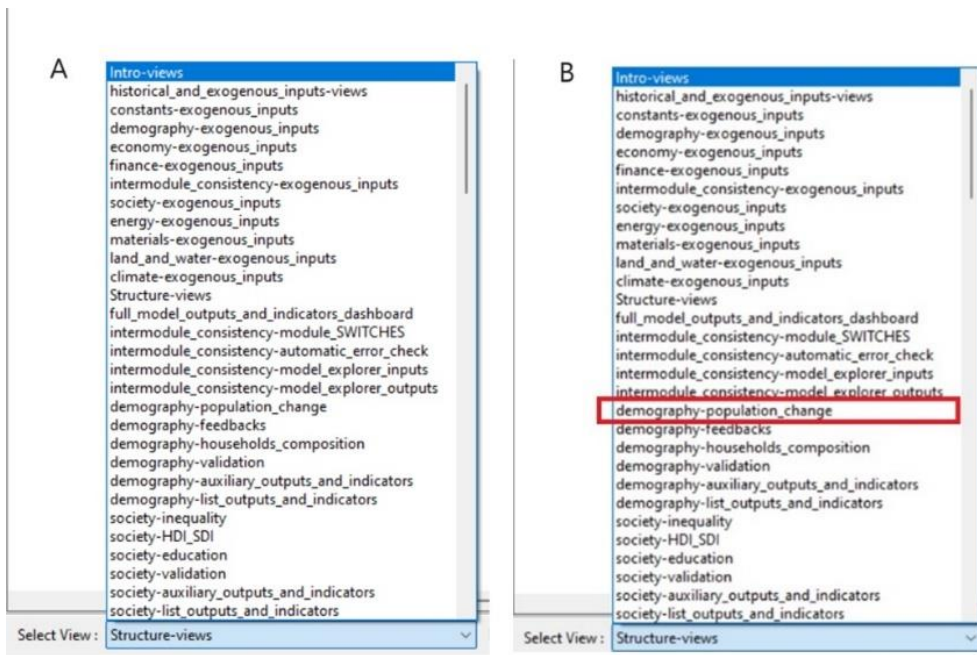
Figure 6. Select the view with the dropdown menu.

For example: Click on *"demography-population_change"* to display this view (Figure 6.). As you can see on this view the graph "world population" shows no data (Figure 7). The variables and graphs appear empty since no simulation has still not been run.
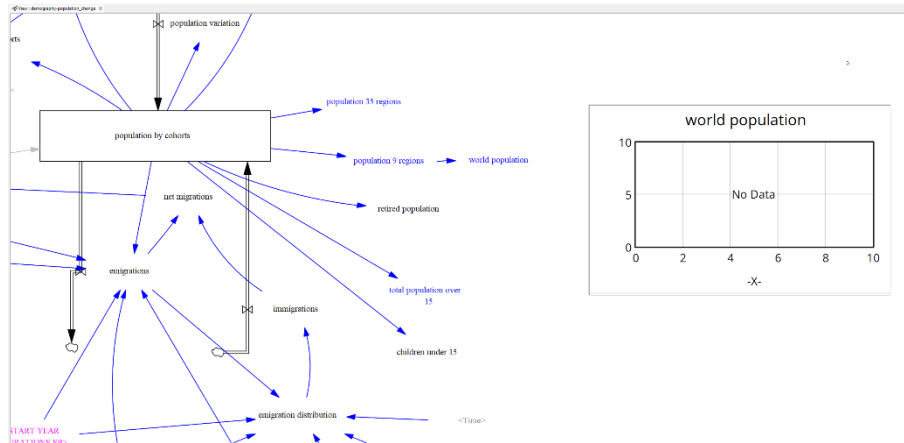

Figure 7. The variables and graphs appear empty.

6. Run of scenarios

When downloading the model, there is a by-default parametrization of the scenario inputs. This parametrization refers just to an initialization of the model and should not be considered a consistent baseline or reference scenario. Model users should parametrize the input parameters depending on the scenarios they wish to simulate. It is important to note that as WILIAM is a big model, running it compiled takes 3' approximate in Vensim DSS (and 30' without compiling), and around 1 hour in Model Reader. These numbers are for a 32GB RAM relatively new PC.

Hence, compiling is very recommendable, especially if the user is going to make several changes and try different scenarios. When compiled the first time, the model runs in around 8'. Any other modification done after compiling the first time will take a few minutes less. In order to do this, please check the **Annex I. Compiling Vensim Model**. Please note that this is only possible with Vensim DSS.

Now it is time to run a scenario. An IAM has dozens to hundreds of policies and hypotheses so a method to deal with complexities and operationalize the construction of scenarios needs to be developed.

In practical terms:

1. Think about a storyline and set of pre-defined goals.

2. Parametrize the policies and hypotheses according to that storyline. Eventually, add more polices and hypotheses.

3. Run your simulation!

IMPORTANT

Each scenario input is independent from the others from a mathematical point of view; however, they are linked by a common storyline, and in some cases also there are some dependences when parametrizing them. Check ReadMe of scenario_parameters.xlsx for more details.

6.1. By-default parametrization

The by-default parametrization of the model does not consist of a fully consistently set of scenario inputs, although in general the default parametrization corresponds to current trends.

Press the button *Run*, located in the upper part of the screen (Figure 9). Vensim will simulate this scenario using data present in the **scenario_parameters.xlsx**.
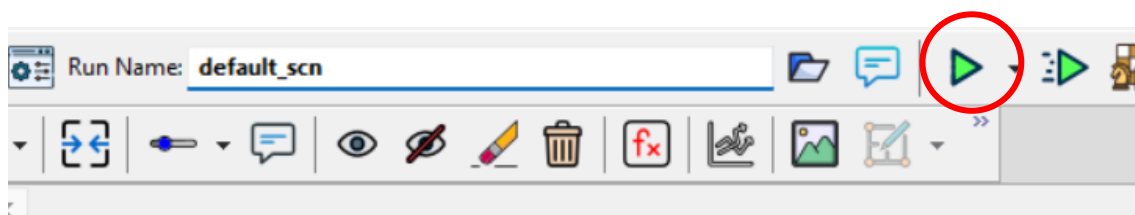

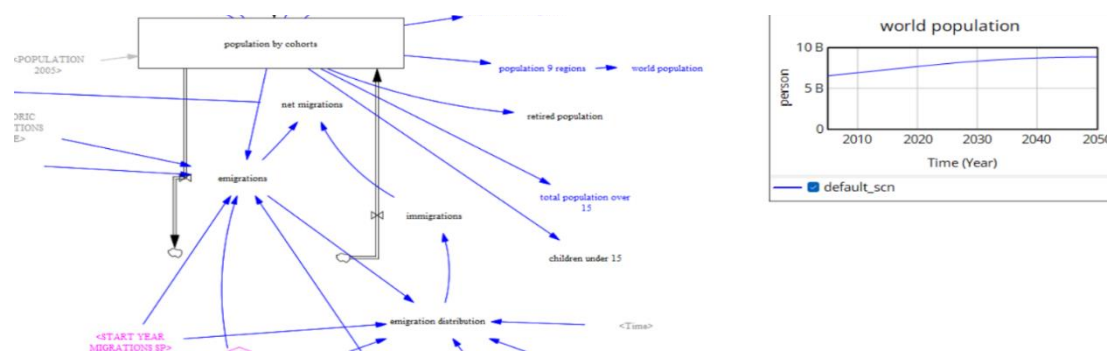*Figure 8. Run button in Vensim DSS. It is the same in Vensim Model Reader*

Figure 9. World population graph after simulation.

Be sure that the Excel files are closed when simulating. If the simulation has succeeded, the view will now show the trajectories of the variables in the graphs (in this view World Population) (Figure 10):

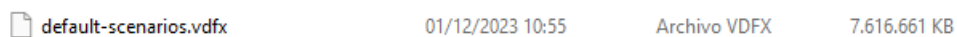The output of the simulations is stored in a .vdfx file: **default-scenarios.vdf**.

Figure 10. default-scenarios file.

6.2. Customized scenarios

It is possible to create new scenarios by modifying the policies and hypotheses in the file **scenario_parameters.xlsx**. We recommend the user to check the tab *list_policies_hypotheses*, so they get familiar with the meaning of the different values that they can apply to a policy or a hypothesis, and use it as a "control panel" for each scenario simulated.
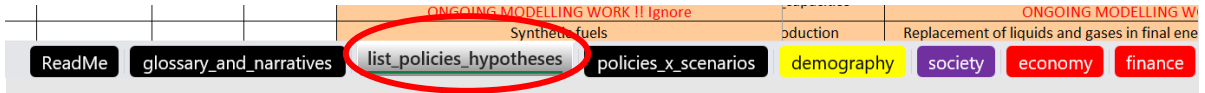

Figure 11. View of the Excel sheets.

This policy target defines the fertility rates for the future in regions by 2050. Values are based on the historical period (2005-2020). SELECTION: low fertility rates (1, left box in sheet "demography_data"), average (2, box in the middle in sheet "demography_data"), or high (3, right box in sheet "demography_data")

Figure 12. Excel sheet "list_policies_hypotheses"

The file scenario_parameters.xlsx contains one tab per module. Following the example used in 6.1., if the user wants to make changes in the world population, they should use the values specified in the *list_policies_hypotheses* tab. Then the change has to be made in the corresponding policy in the *demography* tab.

In this case, to introduce a policy that modifies the policy target *Fertility rates*, the user needs to select between three by-default options: 1, 2 and 3. It is important to check which values can be applied to the different policies in the mentioned Excel file (Figure 12).

Therefore, to modify the *Fertility rates* go to the "demography" tab and introduce the new chosen values for each region that will be a component of the new scenario (Figure 13).

LIST OF ECONOMY POLICIES AND HYPOTHESIS		
FERTILITY_RATES_SP		
POLICY SCENARIO PARAMETERS	TARGET_YEAR_FERTILITY_RATES_SP	OBJECTIVE_FERTILITY_RATES_SP
REGIONS_I|_UNIT	YEAR	DMNL
AUT	2050	2
BEL	2050	2
BGR	2050	2
HRV	2050	2
CYP	2050	2
CZE	2050	2
DNK	2050	2
EST	2050	2
FIN	2050	2
FRA	2050	2
DEU	2050	2
GRC	2050	2
HUN	2050	2
IRL	2050	2
ITA	2050	2
LVA	2050	2
LTU	2050	2
LUX	2050	2
MLT	2050	2
NLD	2050	2
POL	2050	2
PRT	2050	2
ROU	2050	2
SVK	2050	2
SVN	2050	2
ESP	2050	2
SWE	2050	2
GBR	2050	2
CHI	2050	2
EASOC	2050	2
IND	2050	2
LATAM	2050	2
RUS	2050	2
USMCA	2050	2
LROW	2050	2

LIFE_EXPECTANCY_AT_BIRTH_SP		
POLICY SCENARIO PARAMETERS	TARGET_YEAR_LIFE_EXPECTANCY_AT_BIRTH_SP	OBJECTIVE_LIFE_EXPECTANCY_AT_BIRTH_SP
REGIONS_I|_UNIT	YEAR	DMNL
Austria	2050	1
Belgium	2050	1
Bulgaria	2050	2

ReadMe | glossary_and_narratives | list_policies_hypotheses | policies_x_scenarios | demography | society | economy | finance | energy | energy-transport | materials | land_and_water | climate

Figure 11. Editing of fertility rates policy in the scenario_parameters.xlsx Excel file.

IMPORTANT

Remember to save the Excel file and close it before running the new scenario with Vensim.

6.3. Switches of WILIAM

/scenario_parameters/switches.xlsx includes options to (de)activate links inside the model. These SWITCHES have different technical purposes such as modularizing the model and help doing testing and validation. Hence, these SWITCHES are used during model development and should not be considered scenario inputs when designing and running a scenario with the full model.

Figure 14 LAND AND WATER SWITCH which isolates Land and Water module from the rest of WILIAM (modularization)

IMPORTANT

The change in the by-default setting in switches.xlsx will likely cause important behavior changes in the model.

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7. Visualization of results

To better visualize the results given by the new scenarios created by the user, there is a series of views with a summary of the main outputs and indicators of the different modules.

To see the list of the outputs and indicators of each module, the user can change to the view called "nameofthemodule-list_outputs_and_indicators". For example, for the demography module, the view is called "demography-list_outputs_and_indicators", and so on.

Once the user runs the simulation, results will be saved on a file "*RunName.vdxl*" (name the run as you want in the upper field name). Each file represents a run simulation with its dataset. If different simulations are made, the user can remove and/or select the ones to be displayed clicking in the option "*Control panel/Dataset Manager*" (Figure 15). In the example below, two scenarios have been run, but only the "current.vdfx" will be displayed because it is placed at *Loaded datasets* (Figure 16).
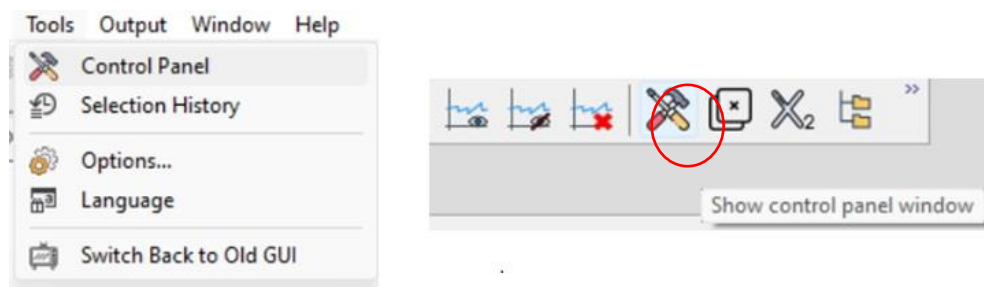
Figure 15. Left: Vensim Model Reader; Right: Vensim DSS
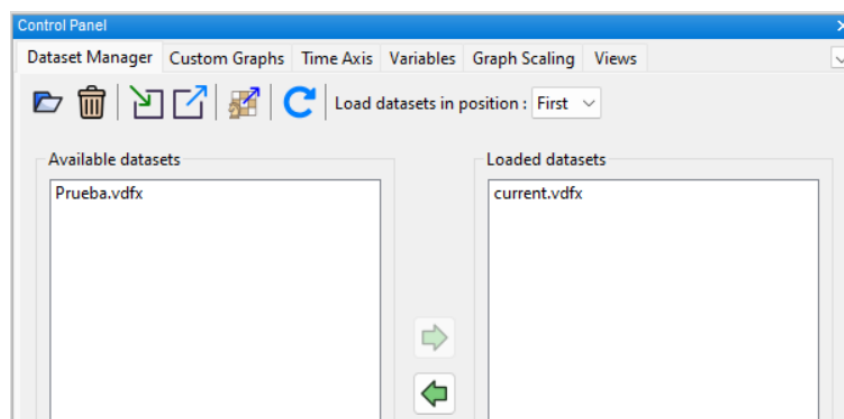
Figure 16. Dataset Manager

To compare the results of different scenarios, the user can go to the general views mentioned above (e.g., "demography-list_outputs_and_indicators") and view the results as graphs.
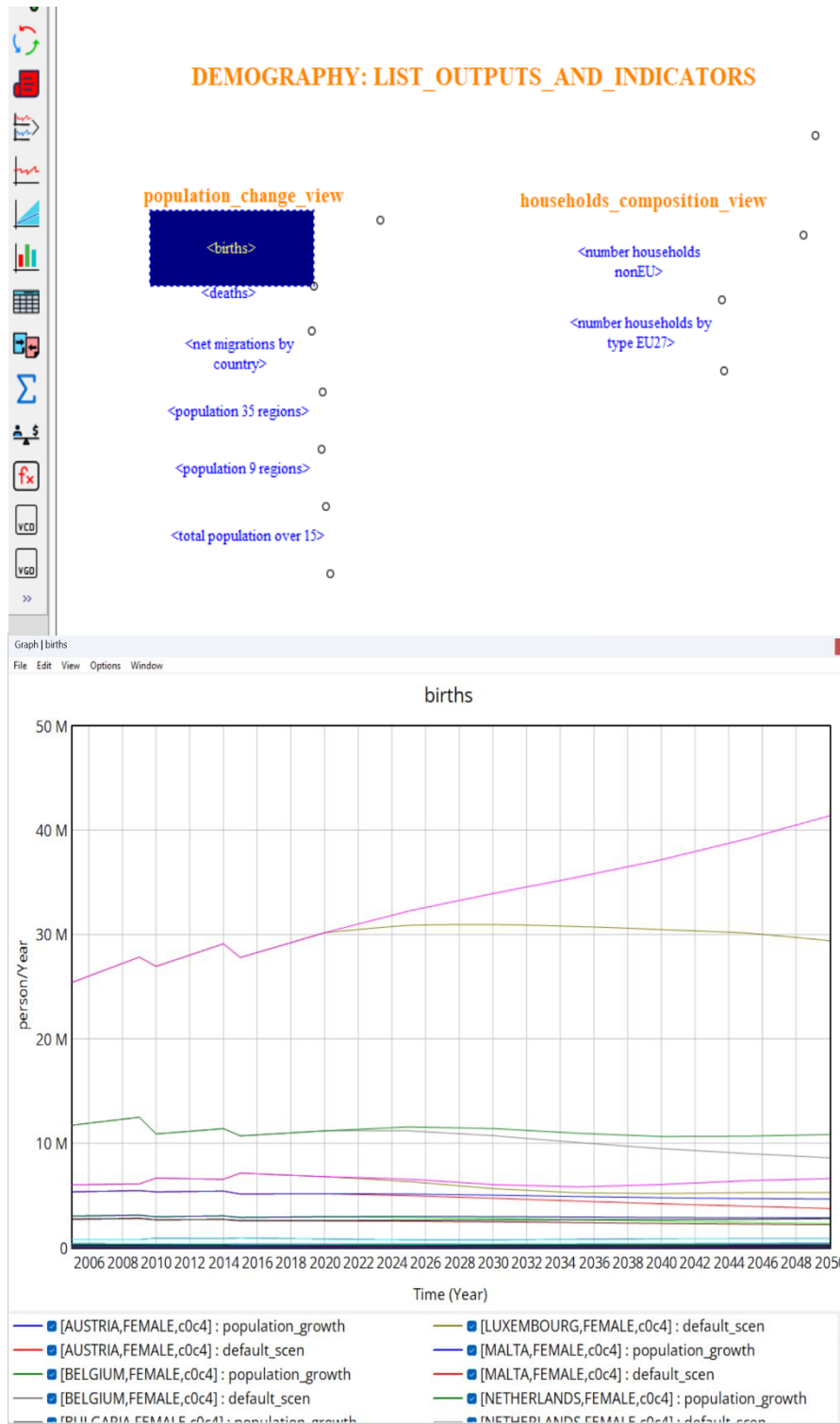

Figure 12. Comparison of scenarios for the variable births.

As the user can obserb in the *Figure 15* datasets are displayed in the graph according to regions, which are explained in *regions.xlsx*. If the user want to change the regions displayed in the graph, the *subscript selection window* must be modified (Figure 17)

Figure 13. Subscripts.

This window shows the different kind of subscripts. Select *REGIONS 36* from the first tab and the second tab will show the elements available. The third tab shows which of these elements are active so the user can put here the ones they want to be on display in the graphs (Figure 18).
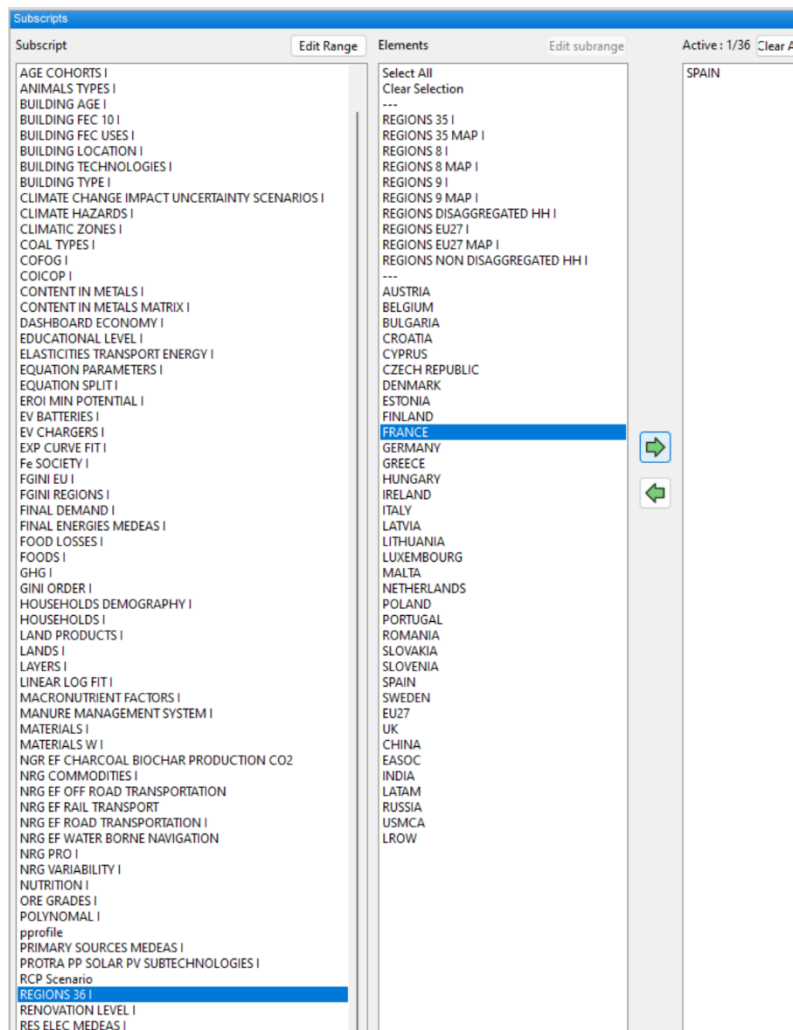
Figure 14. List of subscripts.

16
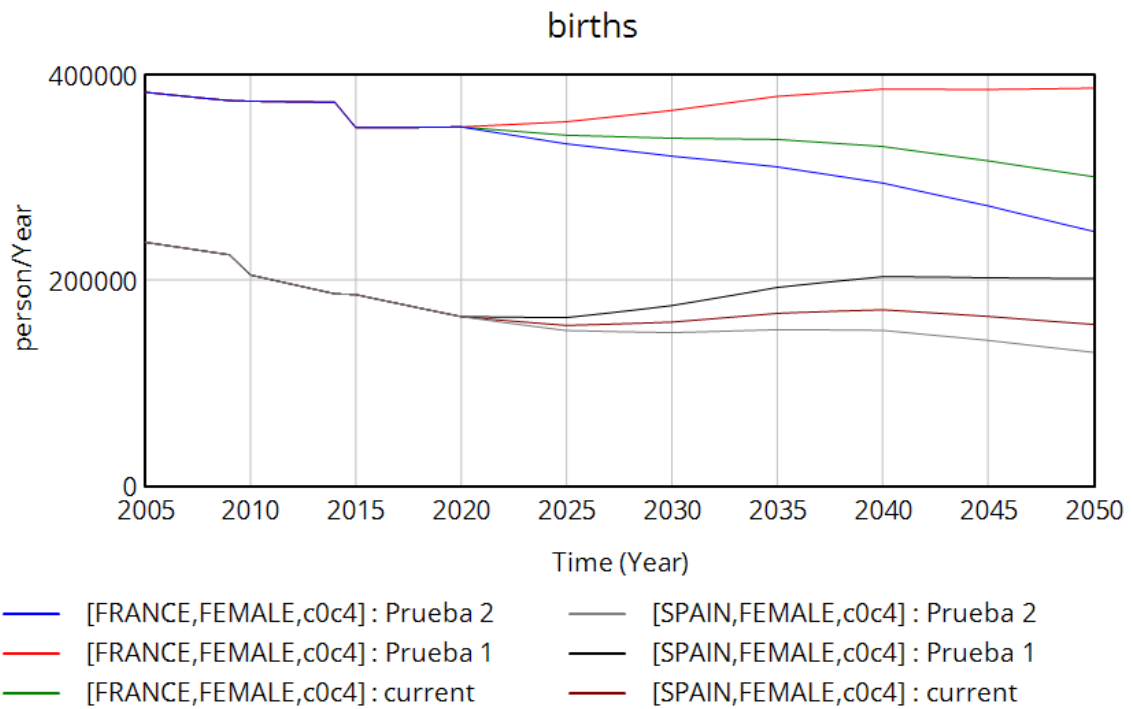
Figure 15. Results by the selected regions.

With some variables it is necessary to select some subscripts to visualize the results (Figure 20).
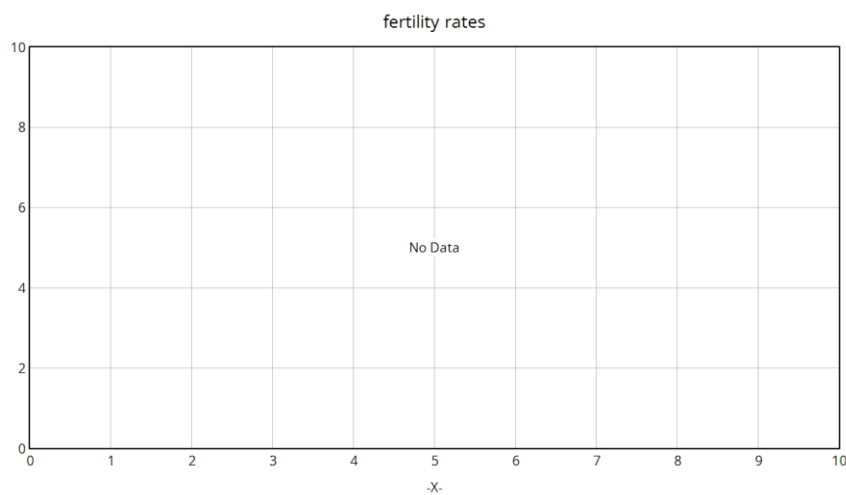
Figure 16 No data because of the lack of subscripts activated.

In order to know which subscripts need to be activated the user must select the variable and then click on " Edit " from the toolbar and then " Set subscripts ". A window will appear with the subscripts the user needs to activate. (Figure 21, 22)
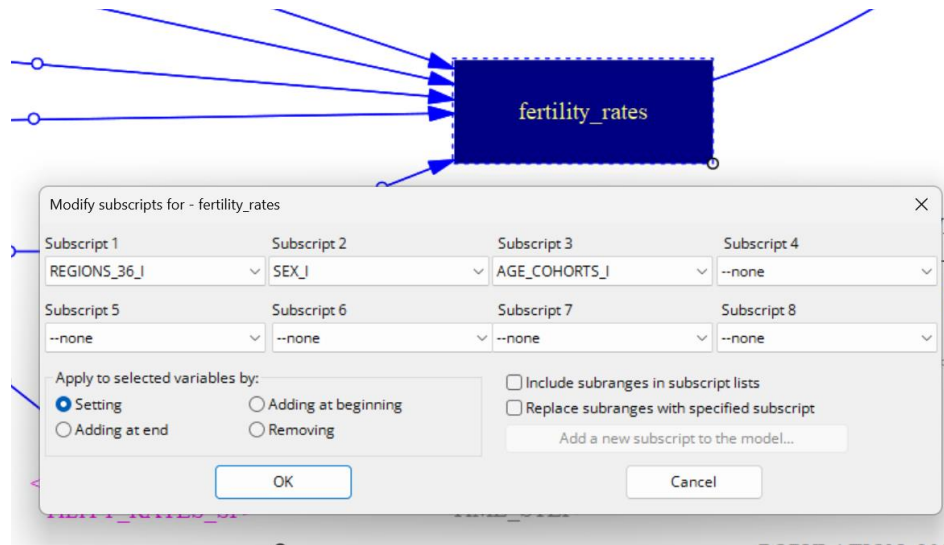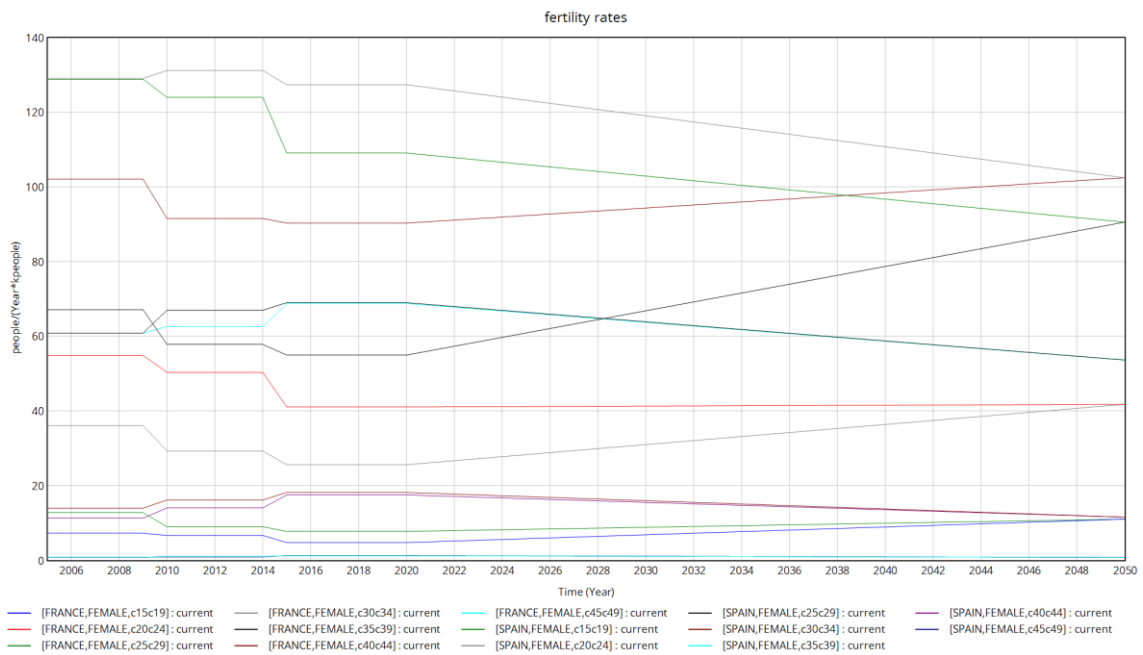
Figure 17 Set subscripts

Figure 18 Results activating subscripts (fertility ages from AGE COHORTS; France and Spain from REGION 36; male and female from SEX)

Another remarkable option available on the *Control Panel* is *Custom Graphs.* Users can create graphs to compare results of variables from different scenarios or datasets (Figure 23). For example, create a graph which display the variables: Deaths, Births and population variation in the scenarios "Current" and "Prueba" (Figure 24).
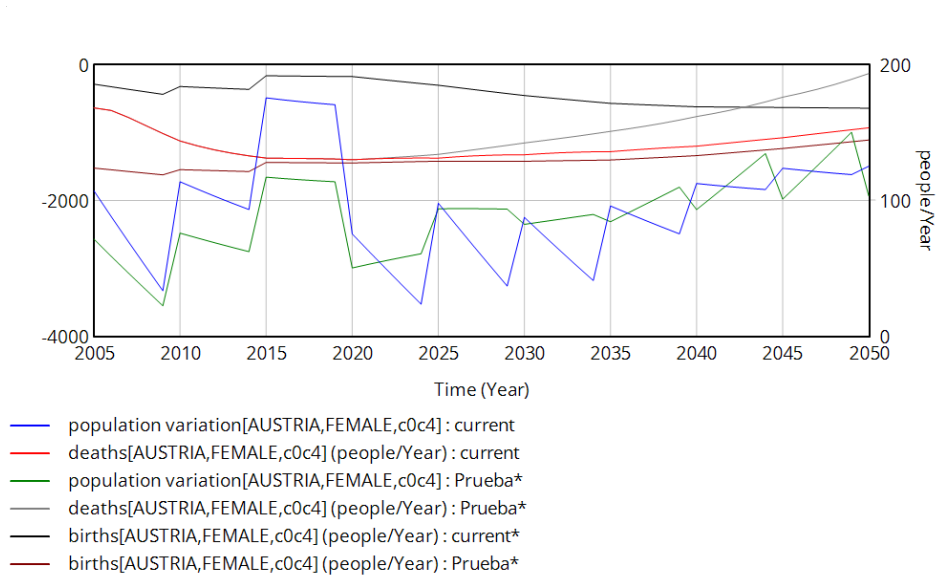

Figure 19. Customizing graphs.

Figure 20. Customized graph.

Annex

Annex I. Compiling Vensim Model for Vensim DSS

1. Install a C compiler:

In this manual we will use Microsoft Visual Studio Community **2022**:

a) Download link: [Descargar Visual Studio Tools: instalación gratuita para Windows, Mac, Linux (microsoft.com)](#)

b) In the linked page select the "Download Community 2022" option:

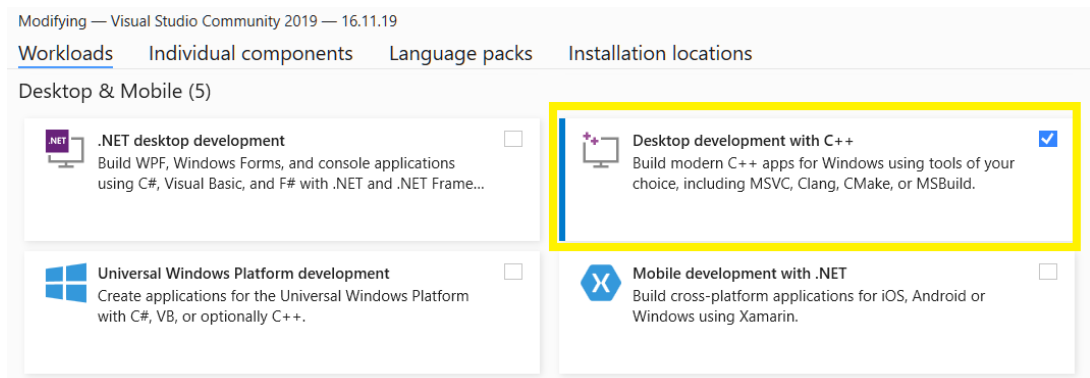c) During the installation process go to Workloads option and select **"Desktop development with C++"**:

Figure 25

d) If you do not want to install unnecessary optional packages, uncheck all of them from the "Optional" part except the two first packages:

 1. ***MSVC v142 – VS 2022 C++ x64/x86 build tools***
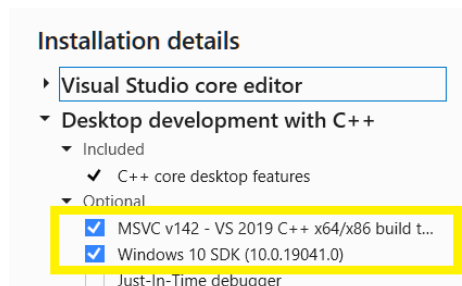
 2. ***Windows 11 SDK***

Figure 26

e) Install Visual Studio

2. **Prepare the compilation environment.**

a) Search for the "VCVARS64.bat" file generated by the Visual Studio installation (only copy the file path, it is necessary in the next step). In Win 11 OS the complete path can be:

"C:\ProgramFiles(x86)\MicrosoftVisualStudio\2022\Community\VC\Auxiliary\Build"

or

"C:\ProgramFiles\MicrosoftVisualStudio\2022\Community\VC\Auxiliary\Build"

b) Go to the Vensim installation directory and edit the "**MDLDP64.bat**" file (this is usually found in the location "C:\Users\Public\Vensim9\COMP"). If the Vensim program is installed in any of the protected Windows folders, such as "C:\Program Files (x86)" or "C:\Program Files" the compilation process will fail because these types of folders need administrative rights to access, therefore Vensim needs to be installed in the unprotected folders such as "C:\Users\Public".
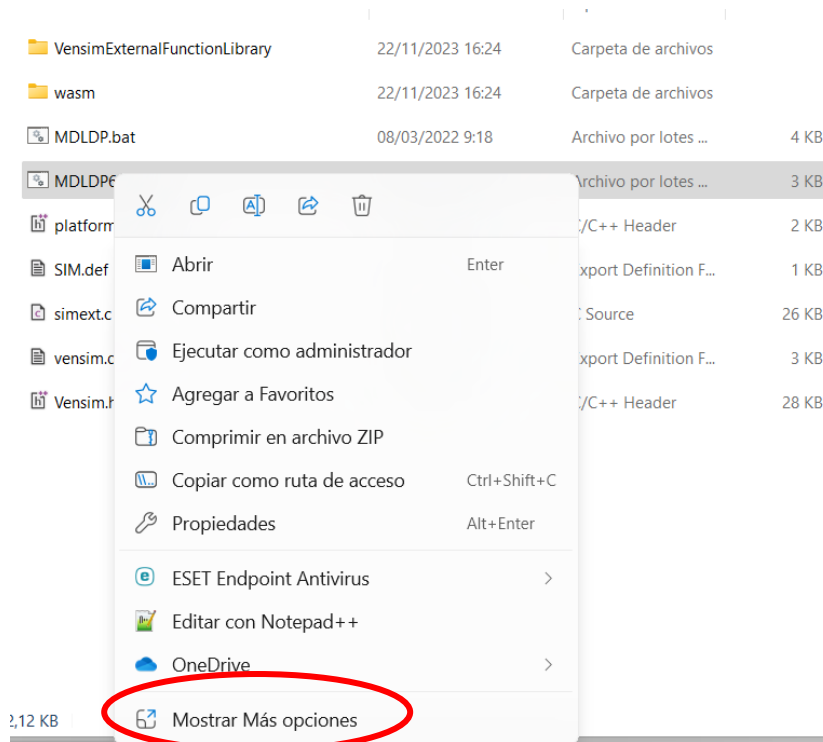
Figure 27

Note that in Windows 11 it is necessary to press "ore options" to edit the code.

c) Search for the line "**if exist mdl.obj del mdl.obj**" and delete all the code above this line except the "@ECHO ON".

d) Add the path to the previous found "vcvars64.bat" file (step 2), after the "@ECHO ON" line with the next command:

call "C:\Program Files (x86)\Microsoft Visual Studio\2022\Community\VC\Auxiliary\Build\vcvars64.bat"

e) The final code of the MDLDP64.bat file should look something like:

23

@ECHO ON

call "C:\Program Files (x86)\Microsoft Visual Studio\2022\Community\VC\Auxiliary\Build\vcvars64.bat"

if exist mdl.obj del mdl.obj

if exist %3.dll del %3.dll

if .%2 == . goto noinclude

...

    f)   Save the MDLDP64.bat file

3. **Modify the Vensim options.**

Select in Vensim the path to the MDLDP64.bat file with the "Browse" button:

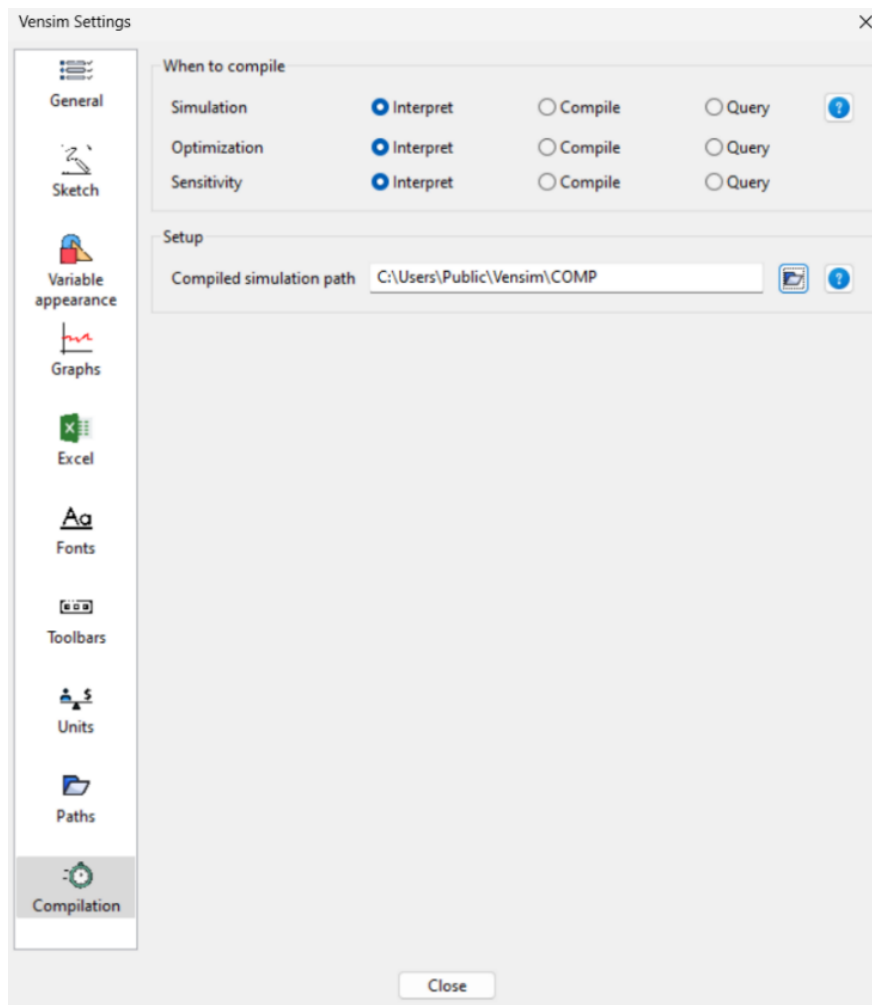Vensim -> Tools -> Options -> Compilation:

Figure 28

a) Modify the Vensim options in order to compile the model:

Tools -> Compilation -> select "Query" for Simulation, Optimization and Sensitivity -> Close.
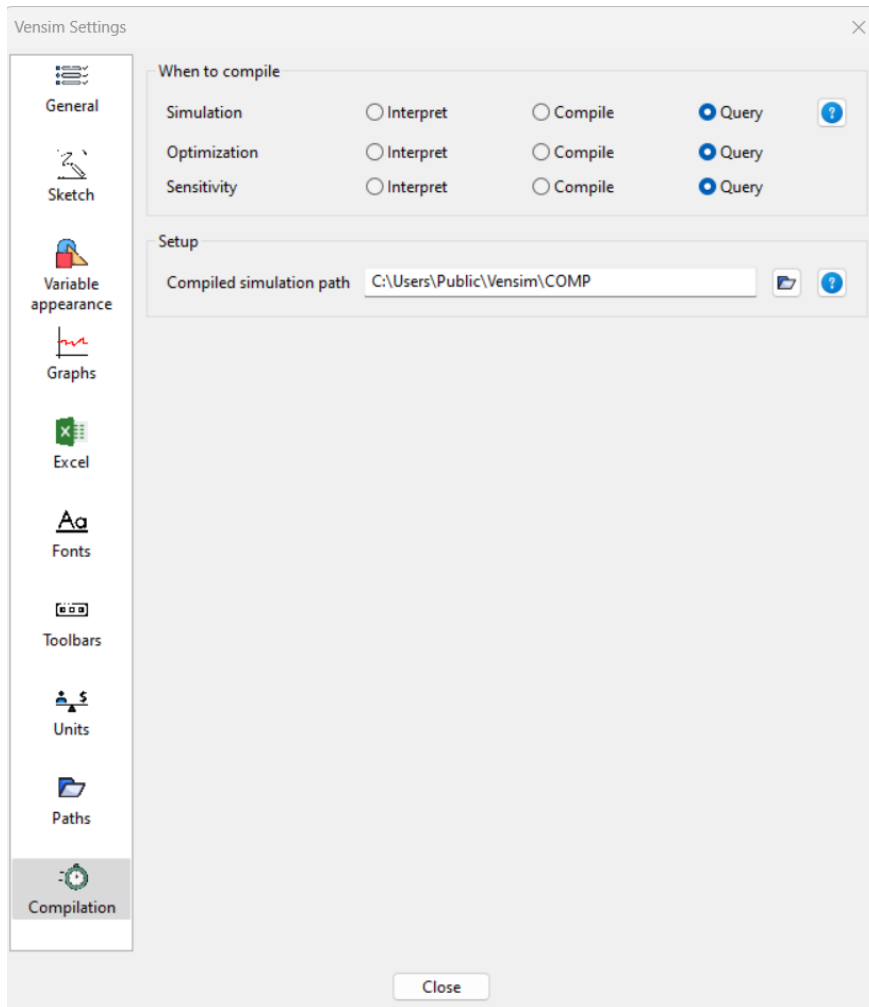
Figure 29

4. Run the model.

    a) Now the first time you run a simulation you will be asked (**Simulation: Query** previous option) if you want to compile or not the model:
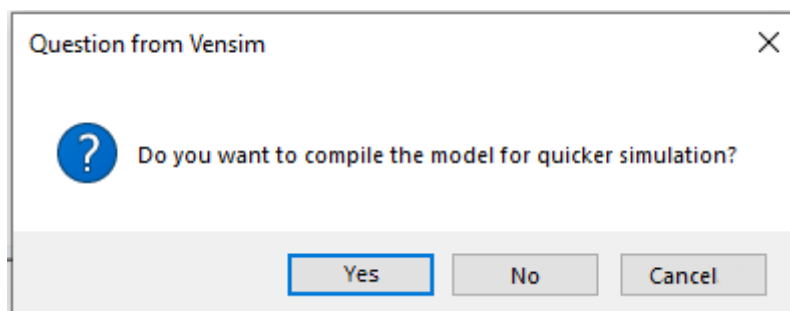

Figure 30

b) Vensim will generate the compiled model and after this, run the compiled model.

c) If the model has not been modified (.mdl file), the next times you perform a simulation Vensim will directly run the compiled model, if there are changes in the model then Vensim needs to generate again a new compiled version of the model. Any change in the input files (*.xlsx* or *.xls* files) does not imply a modification in the Vensim model so it does not need a new compilation of it.