Carbon Sinks QGIS plugin

System User Manual

M Pienaar

South African Environmental Observation Network (SAEON)

January 2020

Version 0.3

Background

This system implements an approach for the search and discovery of Carbon Sinks data, as well as, the ability to calculate the different carbon pools for the national carbon sinks assessment. The conceptual background is given in assessment report. The design characteristics satisfy the following criteria:

1. Simple to use
2. Highly integrated with the Carbon Sinks atlas (data can be loaded directly into QGIS from online metadata resources)
3. Spatially explicit
4. Adaptable with changing priorities
5. Carbon sinks outputs are able to be modified by end users

Getting started

The system will run on any PC loaded with QGIS 3x (but currently not QGIS 3.10). In the plugin menu item of QGIS, click the 'Manage and Install Plugins…' to open the plugins dialog. Navigate to the settings option and make sure 'Show also experimental plugins' is checked (see Figure 1A), then choose the 'Install from zip' option and select the 'carbon_sinks.zip' file. Click the 'Install Plugin' button to install the plugin (see Figure 1B for an example).

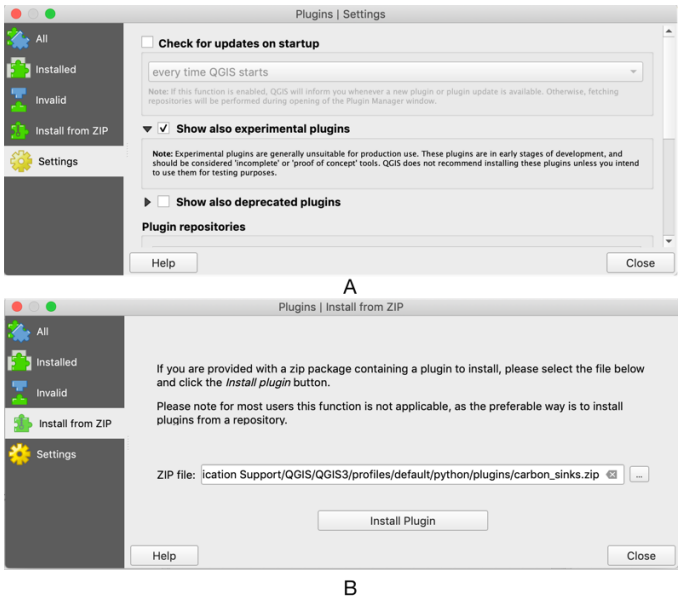

Figure 1. QGIS Manage and Install Plugins screenshot examples to illustrate how to install this plugin.

The plugin has two main interfaces (shown in Figure 2): The Carbon Sinks window (a search and discovery interface which opens when the plugin is clicked); and the Model builder

(accessible from the ‘Model’ button in the main Carbon Sinks window). Each of these is described in more detail below.

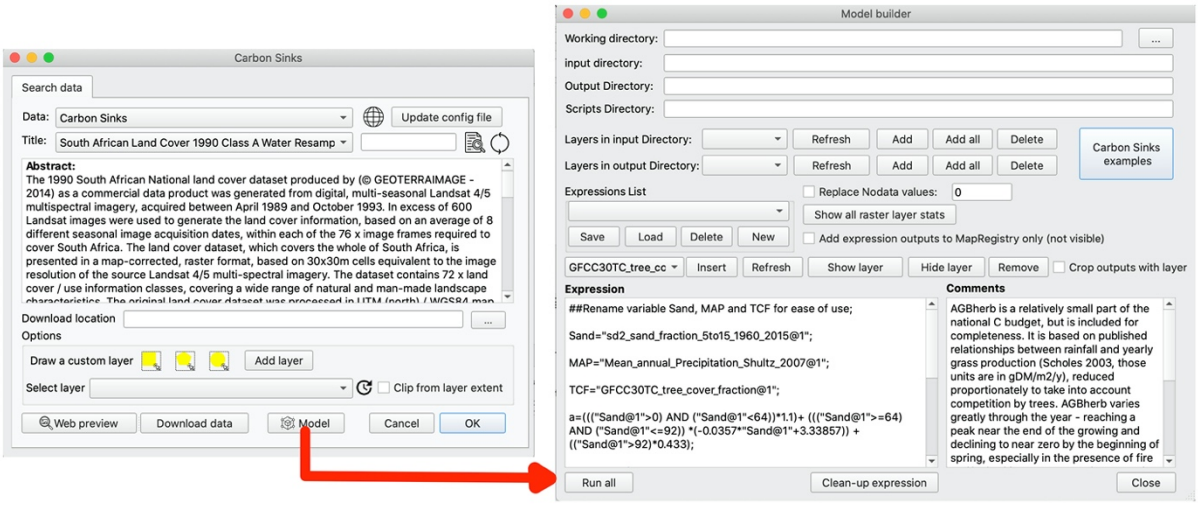

Figure 2. Main interfaces for the QGIS Carbon Sinks Plugin.

Search and Discovery

This section provides details on the search and discovery interface of the carbon sinks QGIS plugin, and what each button can be used for. If you open the carbon sinks plugin, you will enter this section (a ‘labelled’ screenshot is shown in Figure 3). Its purpose is to search for and download data directly into QGIS from the carbon sinks metadata records. If you already have data or wish to use your own data, you do not have to do anything; you can go straight to the ‘Model‘ section. If you are gathering data for the first time or wish to re-download data, you will need to go here. The data used as inputs for the Carbon Sinks assessment comes from a wide range of sources, which have all been resampled into a 1x1km resolution aggregate of the Biodiversity Directorate and STATS SA 100m Basic Spatial Unit or BSU raster in Albers Equal area (+proj=aea +lat_1=-22 +lat_2=-38 +lat_0=-30 +lon_0=25 +x_0=1400000 +y_0=1300000 +datum=WGS84 +units=m +no_defs). The resampling approach is highly accurate, maintaining >99% of the original volume of information (see https://github.com/SAEON-uLwazi/Block_statistics_resampling).

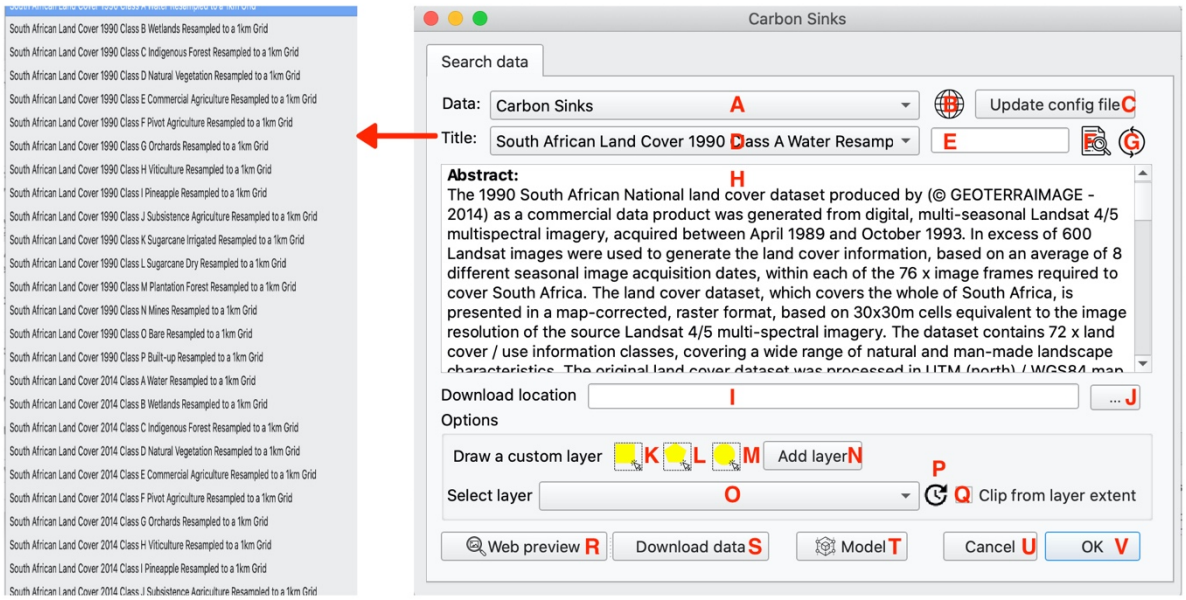

Figure 3. The search and discovery window of the Carbon Sinks QGIS Plugin.

The following labelled components shown in Figure 3 are described in this section:

- **A. The data repository dropdown.**
  - a. Used to select a repository to search (currently only Carbon Sinks v3)
- **B. Connect.**
  - a. This button (the globe image) will connect to the repository (in A) and load the metadata records associated with it.
- **C. Update config file.**
  - a. Used to update a new metadata configuration (download and load a new configuration file when metadata records are added or changed on the system)
- **D. Title drop down**
  - a. Brings up a list of data in the repository (see the data example on the left of Figure 3)
- **E. Search term input field.**
  - a. You can enter any text in this field and press button F (the Search button) to filter the data that matches the search criteria.
- **F. Search Button.**
  - a. Used to search the metadata records containing the search criteria (entered in E)
- **G. Reset the data**
  - a. Used to clear the search result and reload all records from the main repository.
- **H. Metadata display area.**
  - a. This is the main display area for metadata summary records associated with a selection from the title dropdown list (see D above)
- **I. Download location**

a. This is the path on a local computer where all data will be downloaded. It can be pasted manually, or selected using a filechooser option (button J)

J. Select download location button

a. This button will open a filechooser window to allow a user to select a directory where data should be downloaded to. The path will be pasted into the download location field (I).

K. Draw custom rectangle

a. This button allows a user to draw a rectangle on the QGIS map area to use as a clipping layer to subset data (see Figure 4 for an example of drawing a rectangle and saving it as a new QGIS map layer)

L. Draw custom polygon

a. This button allows a user to draw a rectangle on the QGIS map area to use as a clipping layer to subset data (see Figure 4 for an example of drawing a rectangle and saving it as a new QGIS map layer)

M. Draw custom circle

a. This button allows a user to draw a circle on the QGIS map area to use as a clipping layer to subset data (see Figure 4 for an example of drawing a rectangle and saving it as a new QGIS map layer)

N. Add Layer

a. This button allows a user to add built in layers, such a outline of South Africa to use for clipping data.

O. Select a clipping layer dropdown.

a. This dropdown will list all layers that are loaded in QGIS, including those drawn using (K,L,and M), which can to use a clip or subset data from the main repository. It uses the extent from both vector and raster layers.

P. Refresh the clipping layer dropdown

a. This button will refresh the clipping layer dropdown list will layers loaded into QGIS.

Q. Clip from layer checkbox

a. If this checkbox is ticked, the layer selected in O above will be used to subset the data when the Download data (S) button is pressed.

R. The Web preview button

a. This button will load the metadata record of the data selected in the Title dropdown list (D) and display it in a web browser.

S. Download data

a. This button will download the raw data associated with the title dropdown list (D) into the download directory selected in the download location (I). If the Clip from layer checkbox is clicked, it will subset the data using the extent of the layer selected in the clipping layer dropdown (O)

T. Model

a. This button will bring up the Carbon Sinks Model builder window (Shown on the right-hand side of Figure 2 and discussed in the next section)

U. Cancel.

a. This button will close the plugin window

V. **Ok.**

a. This button will close the plugin window

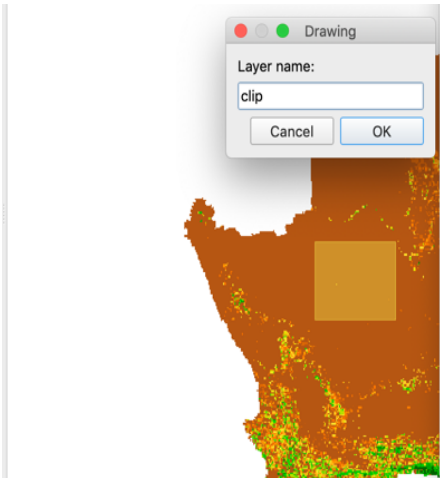

Figure 4. Screenshot of the 'Preview' and 'Draw a custom layer' options.

Model Builder

The model builder interface (shown in Figure 2 [right hand side] and labelled in Figure 5) gives you full control over how outputs are calculated. It uses the raster calculator processing algorithm of QGIS to perform the calculations. Algorithms / outputs are built up from top to bottom (by creating a raster output layer in each row with the ability to use that output in the following row as an input, and so on). It may take some time at first getting used to how the system works, but by simply 'playing around' and following the examples it will become clear. The novelty of the system is its capability to allow multiple ('unlimited' and relatively complex) spatially explicit layers to be created using the raster calculator logic. Each output can be uniquely designed to meet specific needs. The underlying spatial framework uses the GDAL translator library for raster data manipulation. An output could be developed through multiple combinations of other layers, which in themselves could be created by defining a output specific algorithm. The expressions used in the model builder follow the same logic described in the Raster calculator documentation of QGIS (see https://docs.qgis.org/2.8/en/docs/user_manual/working_with_raster/raster_calculator.html), and allows multiple outputs to be created simultaneously.

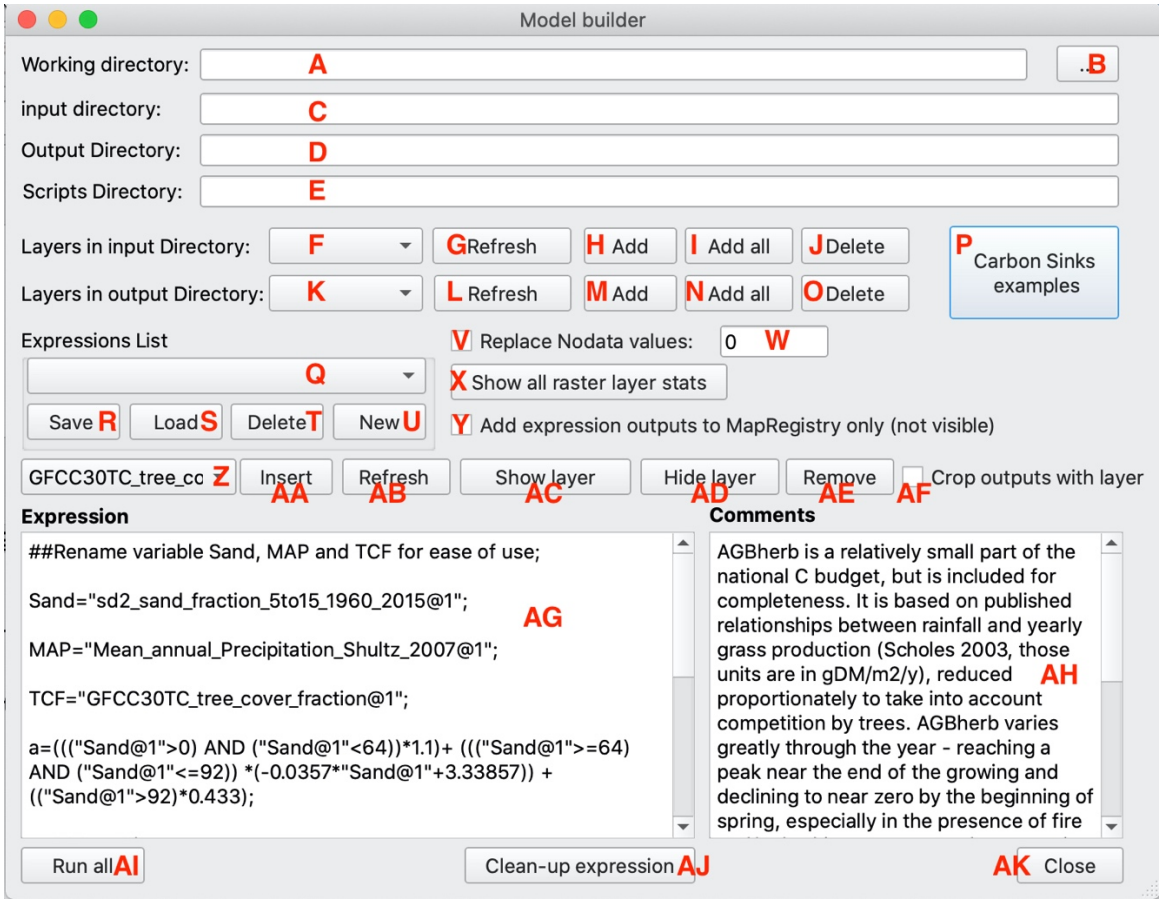

Figure 5. Screenshot of the Model builder interface with functions described below.

The following components are described in this section (shown in Figure 5):

A – E. This is the working directory with input sub-directory, output sub-directory, and scripts sub-directory locations. To set the current working directory, Press button B, which will bring up a filechooser window that allows the path of the working directory to be set. The input, output and script directory will be created in the working directory if they don't already exist, and their location will be displayed in C-E.

F – O . These options allow you to load or delete layers in the input and output Directories. **F** and **K** are dropdown lists that show all the raster layers (.tif) in the input and output directories. **G** and L can be used to refresh these lists. **H** and **M** will add the layer selected in the dropdown list (**F** or **K**), whereas **I** and **N** will add all layers in the input or output directory. **J** and **O** will delete a selected layer in **F** or **K** (caution is advised when deleting, as it will permanently delete the data from your computer. When either the add (**H** and **M**) or Add All (**I** and **N**) buttons are pressed an option dialog will appear (shown in Figure 6) prompting you to select whether you wish to make the layer visible or just add it to the registry. If the 'Add to MapRegistry and QGIS Layer panel' option is checked (default) the layer will be added to the QGIS layer registry and be loaded into the layer panel table of contents, which allows them to be displayed in the main map area of QGIS. If the 'Add to MapRegistry only (not visible)' option is checked, the layer will be available in the model builder, but not visible in the main QGIS layer panel or map area. This is a useful option for when QGIS becomes 'too busy' with many layers for instance.

Figure 6. Add layer options

P. This option will load a Carbon Sinks example expression and data (the calculation of the Above Ground Biomass Herb layer).

Q – U. These options allow you to save, load, delete or define a new set of expressions. **Q** is a dropdown list of all saved expressions. **R** allows you to save the current expression and associated comments in the expression panel **AH** and comments panel **AI**. **S** will load an expression listed in the dropdown list **Q. T** will delete a selected expression in the dropdown list (**Q**), and **U** will clear the current expression (in the expression panel in **AG** and its comments in **AH**).

V and W. These two options will replace all 'nodata' values in all layers defined or used in an expression or series of expressions defined in the expression panel **AG** with a specific value in **W** (provided **V** is checked). **W** is the user defined value used to replace 'nodata' values.

X. Used to get summary statistics for all raster layers loaded into QGIS. When the 'Quick layer stats' button (**X**) is pressed it will bring up a table of values [Layer name, Min, Max, Sum, and Mean] (see Figure 7 for an example)

Y. If the 'Add expression outputs to MapRegistry only (not visible)' checkbox (**Y**) is checked, all layers created using an expression will load into the QGIS map registry, but will not visible in the main QGIS layer panel or map area. This is a useful option for when QGIS becomes 'too busy' with many layers for instance.

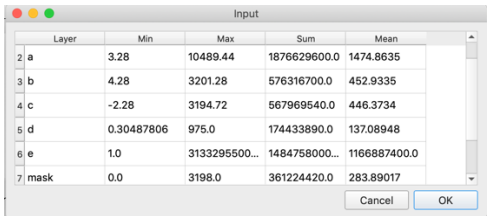

Figure 7. Example of raster layer statistics.

Z – AF. These options allow you to view all layers loaded into the QGIS map registry, insert a selected layer into an expression, refresh the layer list, load a layer (not visable) into the layer panel and QGIS map interface, hide a layer, remove a layer, and crop all of the outputs generated by an expression to a selected layer. **Z** is a dropdown list of all layers loaded into the QGIS map registry. **AA** will insert a text string representation of the layer selected in the dropdown list (**Z)** into the current caret position (position of the text cursor) in the expression panel **AG**. **AB** will refresh the dropdown list (**Z). AC** will load (or make visible) a selected layer in **Z** into the QGIS layer panel (if not already there). **AD** will remove (hide) a selected layer in **Z** from the QGIS layer panel and map area, but will keep it in the map registry. **AE** will remove a selected layer in **Z** from the QGIS layer panel, map area, and registry, but will not delete the original source of the layer from your computer (if it has been saved

somewhere). **AF** will crop all of the outputs generated by an expression to the selected layer in **Z,** according to either the layers extent (if the selected layer is a raster), or to the outline of a polygon (if the selected layer is a polygon vector layer) – this feature is still experimental and needs proper testing, however.

AG. This text area allows a user to build and run expressions. Here all layers (both outputs and inputs) are referenced using inverted commas (e.g. "layer_name"). The basic structure of an expression takes the form: "output_layer"= "input_layer" + expression parameters;. All expressions end with a semi-colon (;). All the operators, trigonometric functions, and logic functions shown in Figure 8 (screenshot from QGIS raster calculator) can be used to build an expression. Expressions follow the QGIS built in raster calculator logic, and requires that layers append the "@band number". Here, band 1 is assumed for all layers as in "layer@1". A quick start tutorial on how to build basic expressions is given in the following section under the header Basic Examples.

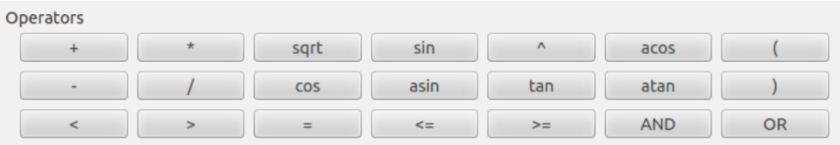

Figure 8. Operators that can be used to build a raster expression.

AH. This is a comments area, which can be used to describe the expressions built in **AG**.

AI. This button will run whatever model has been created in the expression area **AH**.

AJ. This is the clean-up expression button. It will split all strings (expressions / text) that end in a ";" into new lines.

AK. The close button will close the Model builder window (but will first prompt the user in case an expression has not yet been saved).

Basic examples

Building expressions to create output layers

The following examples illustrate how both the QGIS Raster calculator and the model builder (the plugin) can be used. The following simple examples demonstrate a simple expression created in the QGIS raster calculator:

"MAP@1" * 3.28 (will multiply all pixels in the layer by 3.28);
" MAP@1" + 3.28 (will add 3.28 to all pixels in the layer);
" MAP@1" - 3.28 (will subtract 3.28 to all pixels in the layer);
" MAP@1" / 3.28 (will divide all pixels in the layer by 3.28); and
" MAP@1" ^ 3.28 (will raise all pixels in the layer to the power 3.28).

Here, "MAP" = a Mean Annual Precipitation or MAP raster layer, and "@1" is band 1 of the raster. For each expression (assuming that each expression will results in a new raster layer), you will have to open the Raster calculator, define the expression and choose an output name (see the screenshot example in Figure 9)

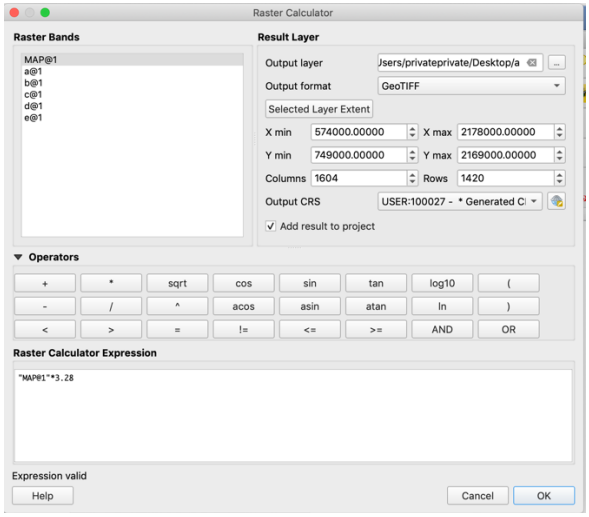

Figure 9. Basic example of building an expression using the raster calculator in QGIS.

The same example can be replicated in the Carbon sinks plugin simultaneously by first loading example data (by pressing the carbon sinks example button (**P**)) and pasting the following text (note we have created a new layer called “MAP” from the "Mean_annual_Precipitation_Shultz_2007@1" layer that comes with the examples for ease of use). Note the “;” after each expression:

"MAP"="Mean_annual_Precipitation_Shultz_2007@1";
"a"="MAP@1" * 3.28;
"b"="MAP@1" + 3.28;
"c"="MAP@1" - 3.28;
"d"="MAP@1" / 3.28;
"e"="MAP@1" ^ 3.28;

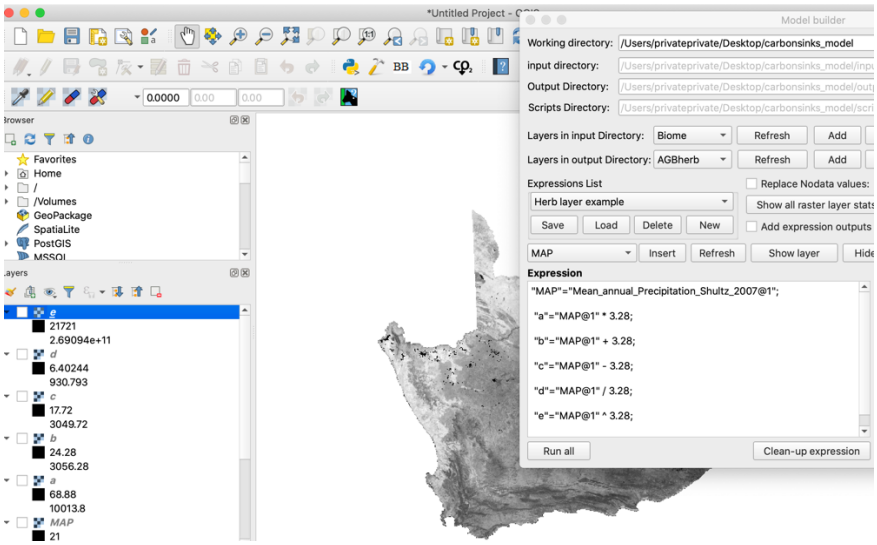

Figure 10. Carbon Sinks Model builder example of building the multiple simultaneous expressions of the raster calculator example in Figure 9.

Creating or using a mask

If you wish to mask out parts of a raster, you can use the following expression in the raster calculator:

("MAP@1" >= 500) * "MAP@1".

Here, the expression in the brackets ("map@1 >= 50) is equivalent to:
if (Map@1 >= 500) then 1, else 0. Hence, all values greater than or equal to 50, are first given a value of 1, then these are multiplied by the MAP layer (to return the original values and zero for all values as they are multiplied by zero). The expression is exactly the same in the model builder, except we give the output a name for example: "mask"=("MAP@1 >=500)*"MAP@1";

Similarly, to reclassify values in the raster using multiple steps, the following expression could be used:

"test" = (("MAP@1" < 500) * 1) + (("MAP@1" >= 500) * 2);

Here, the first part of the expression makes all values in "MAP" <500 = 1 and adds all values in "MAP" >=500=2. See the example in Figure 11.

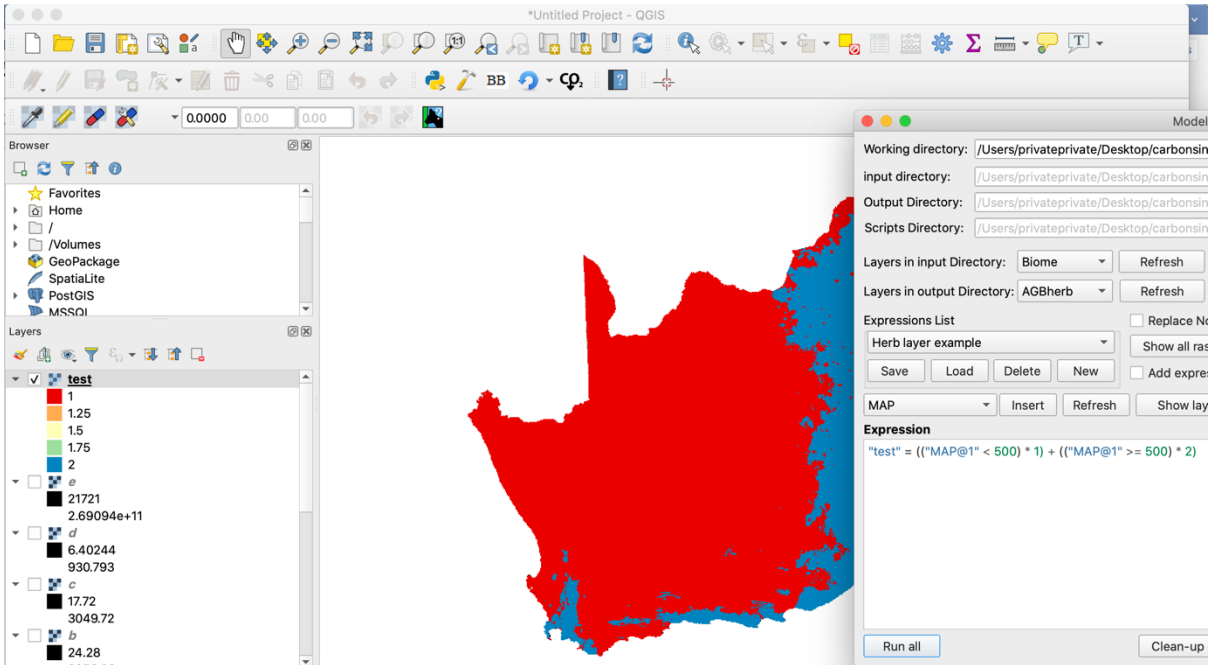

Figure 11. Carbon Sinks Model builder example of reclassifying a raster into two classes.

For other more complex expressions see the examples using the Carbon Sinks examples button (**P**).