

Using SSURGO and STATSGO2 soil data with QSWAT

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Version 1

1 Introduction

SSURGO and STATSGO2 are soil data available for the USA and available free from the web. They are a good, detailed source of soil data to use with QSWAT, but they need some preparation first. This document explains how to obtain and prepare SSURGO and STATSGO2 data.

2 Choosing a suitable resolution

We will later be converting soil maps that are shapefiles (also called vector files in QGIS) to grids (also called rasters). We will be asked for a resolution to use, and it is sensible to make the resolution the same as the DEM we are using. Making the resolution smaller is simply wasteful: QSWAT will be reading a soil value for each cell in the DEM, so with a smaller resolution some of our soil data will not be read. Making the resolution larger potentially loses useful soil data. So we need to find the resolution of our DEM, and this needs to be for the DEM in lat-long projection, since we will be converting soil maps when they are in lat-long projection. We proceed as follows:

- Start QGIS and load your DEM, preferably in a lat-long projection version, but otherwise as it is
- Right click on its entry in the *Layers* panel, and select *Save as...*
- The current resolution, horizontal and vertical, is shown in the *Resolution* box. If the DEM is projected, the resolution will be in metres and will show that one grid cell will be, for example, 100 x 100 metres in size. If the DEM is in lat-long (when we also say it is in a geographic coordinate system) the units are degrees, and the resolution will typically be a small fraction of a degree in each direction.
- If the resolution is in degrees, make a note of the values. Otherwise, click the *Change* button beside *CRS* (the coordinate reference system) and in the form that comes up look for the system *WGS84*, with EPSG number 4326. It will probably appear in the *Recently used* list. Otherwise you need to search for it in the lower box, where it is one of the ***Geographic Coordinate Systems***. Select it, so that it appears as *WGS 84* in the *Selected CRS* box, and click *OK*. In the *Save raster layer as...* form we see that the resolution values have changed, and we can make a note of them. Then *Cancel* this form – there is no need to actually save the map.
- The resolutions may be slightly different. For SWAT's Example1, for example, where the projected resolution is 100 x 100, we get values of 0.00108026 and 0.000892786 in lat-long. We will simply use 0.001 for both later.

3 Obtaining the maps

It is convenient to start at the USDA's Geospatial Data Gateway <http://datagateway.nrcs.usda.gov/> From there we select *Order by bounding rectangle* which allows us to input the extent of the area we want the soil map for. We will obtain the maps for SWAT's Example1, a watershed in Texas. We enter longitudes 96W and 95.4W, and latitudes 32.7N and 33.2N. You don't need to be very accurate with these values; make sure you round values away from your area rather than towards it. Make a note of them as you will need them later.

Once you have input the extent, click *Check Desired Coordinates* to see the area you have selected, and revise if necessary. Then click *Submit Desired Coordinates*. This brings up a range of maps that you can download. Scroll down to the *Soils* section and you will see that amongst others we are offered 4

SSURGO 2.2 maps, comprising almost 46MB of data, and a single STATSGO2 map comprising over 12MB. The STATSGO2 map actually covers all of Texas: it is much less detailed than SSURGO. Check whichever of these maps you want and click *CONTINUE* at the bottom.

On the next page you are informed that the maps will be in ESRI Shape format, that they will be in WGS84Geographic projection, and the inclusion option is *Extract*. This is all OK. It will also be delivered free by FTP. Click *CONTINUE*.

On the next page you enter your contact information. If you have used this service before this data will (if you agreed) have been saved. Complete it if necessary and click *CONTINUE*.

You then have a final review page which summarises your order. Click *PLACE ORDER*.

Next you check your email and you will find links to download your zip file(s). Click on the link(s) and save.

If you open the STATSGO2 zip archive you find a text file with information about the map, and another zip archive which in turn contains a couple of sub-folders, some metadata files, and an Access database. Navigate to the *spatial* subfolder, where you can find the shapefile, which comes as four files with suffixes dbf, prj, shp and shx. Select or create a folder, somewhere, which we will call the *soil folder*, and copy these four files into it.

If you open the SSURGO zip archive you find a similar structure, except there are 4 inner zip files. STATSGO2 is organised by state and SSURGO by county. We have maps for 4 counties, identified by the codes TX231, TX467, TX499, and TX610. Open the first inner zip archive, for TX231, and again navigate to the *spatial* subfolder. This time we see a collection of different shapefiles. The one we need is the one containing the string *mu_a*, namely *soilmu_a_tx231.dbf*, *.prj*, *.shp* and *.shx*. Copy those four files to the soil folder, and repeat for the other three inner zip archives.

From now on we will use the SSURGO data. The same procedures will apply to STATSGO2, except that SSURGO, as in this example, typically involves multiple files instead of just one.

4 Converting shapefiles to grids

SSURGO and STATSGO2 maps are shapefiles, and QSWAT uses grids for soil data. It would be possible for QSWAT to use shapefiles, but reading them point-by-point as we need to do is slower than for grids, so it is worth converting them once in advance of running QSWAT..

There are therefore a number of procedures we need to perform to prepare our data:

- converting from shapefiles to grids
- clipping grids to our area of interest
- merging grids
- reprojecting to an “equal area” projection

You might think it would be easiest to merge first, but the size of these files makes this problematic: you may well exceed QGIS's capacity. So we will proceed in the order above.

Start QGIS and load *soilmu_a_tx231.shp*, using *Layer* → *Add Vector Layer* or the corresponding button on the left of the QGIS window. *Browse* to the soil folder, select the file, click *Open*, click *Open* again.

Shapefiles associate one or more attributes with their shapes. If we open the attribute table for a SSURGO shapefile (right click on the entry in the *Layers* panel and select *Open Attribute Table*) we see that there are four attributes: *AREASYMBOL*, *SPATIALVER*, *MUSYM* and *MUKEY*. We need to choose

one as the value to be used in the grid, and it must be numeric. The value we want is *MUKEY*, but unfortunately it is stored as a string. There is a simple procedure to generate an equivalent numeric field. In the attribute table, click on the *Toggle editing mode* button (the leftmost) and then on the *Field calculator* (the rightmost). In the *Field calculator* form (Figure 1) make sure *Create a new field* is checked, enter *MUKEYINT* as the *Output field name*, and if necessary change the *Output field type* to *Whole number (integer)*. Leave the *Output field width* as 10. We create values for the new field by creating an expression, which in our case will be `toint("MUKEY")` (Figure 1). You can simply type this in the *Expression* box, or you can create it by clicking:

- In *Function list*, expand *Conversions* and click twice on *toint*.
- In *Function list*, expand *Fields and Values*, and click twice on *MUKEY*.
- Under *Operators*, click on `)`.

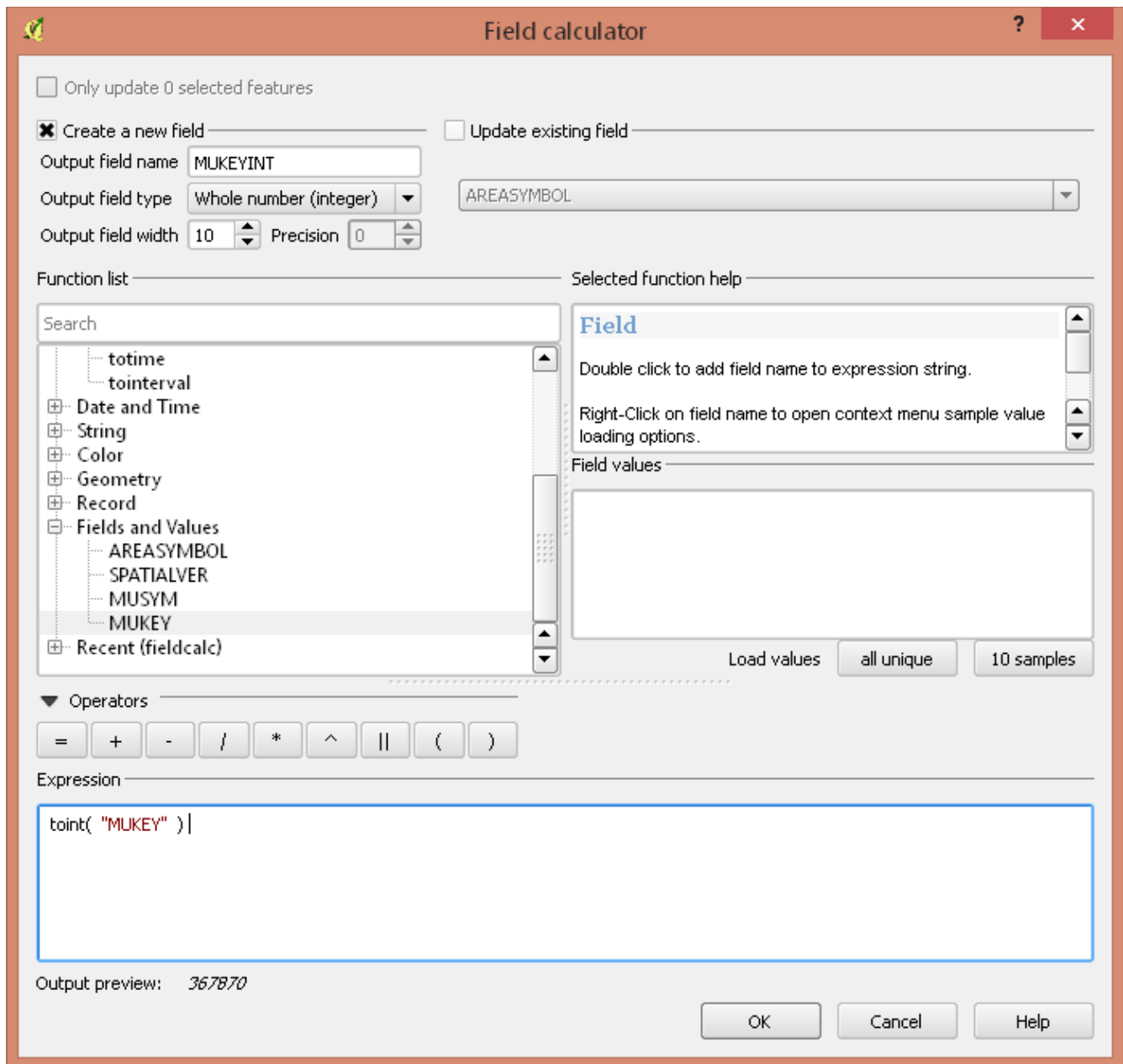


Figure 1: Adding the *MUKEYINT* field

Click *OK* and you will see in the attribute table the new attribute *MUKEYINT* has been added and the values inserted. It is still in editing mode, so click the *Toggle editing* button, then click *Save* in the *Stop editing* form and close the attribute table.

We are now ready to convert to a grid. Use *Raster* → *Conversion* → *Rasterize* to open the *Rasterize (Vector to raster)* form (Figure 2). Select the input shapefile, which will be available in the pull down menu, set the *Attribute field* to *MUKEYINT*, click the *Select* button for the *Output file*, navigate if necessary to the soil folder, and provide a suitable name, such as *tx231_ll*, make sure the file type is *GeoTIFF*, and click *Save*. You will be reminded that you need to decide on the grid's size or resolution. Click *OK* to remove the reminder.

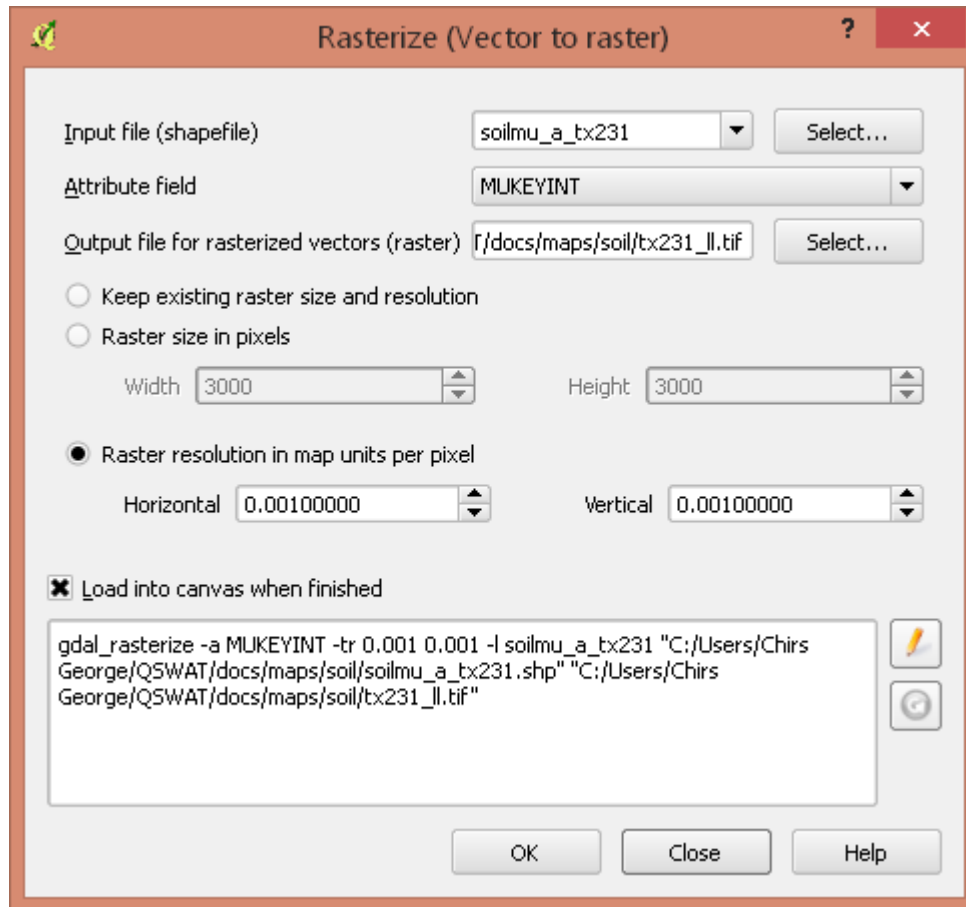


Figure 2: Converting shapefile to grid

We enter the resolution values we found earlier, check *Load into canvas when finished* if necessary, and click *OK*. We are informed when processing is complete – click *OK* – then shown a progress window which we also remove by clicking *OK*. Do not close the *Rasterize* form – we can use it again without having to add the details. Return to the main QGIS window and we see that our raster layer has been added and looks rather strange – white where it overlaps the shapefile and black elsewhere. QGIS has difficulty colouring such files: they have a wide range of values with only a few actually occurring. We will not worry about it: the final map will be coloured by QSWAT.

5 Clipping grids

Grids can be clipped using an extent, which we recorded earlier when we downloaded the soil maps.

(Shapefiles can only be clipped using another shapefile. We could have created a suitable clipping shapefile by drawing a rectangle to match our extent, but if we convert to grid before clipping we avoid having to make this shapefile.) Select the grid in the *Layers* panel, and use *Raster* → *Extraction* → *Clipper* to bring up the *Clipper* form (Figure 4).

The *Input file* should already be chosen, else select it in the pull-down menu. Click *Select* next to *Output file*, navigate to the soil folder, and enter a suitable file name, such as *tx231_ll_clip*. Make sure the file type is *GeoTIFF* and click *Save*. In the *Clipper* form check *No data value*. We can leave the default no data value of 0 since all SSURGO soil keys are large positive integers. Enter the extent, remembering that west longitudes are entered as negative numbers. When you complete entering the extent it is displayed in the map canvas as a coloured rectangle, so you can see it is where it should be. If necessary check *Load into canvas when finished* (Figure 3) and click *OK*. Click *OK* to remove the completion announcement and again to remove the (expected) warning that the extent falls partly outside the grid. Do not close the *Clipper* form, as we will use it again.

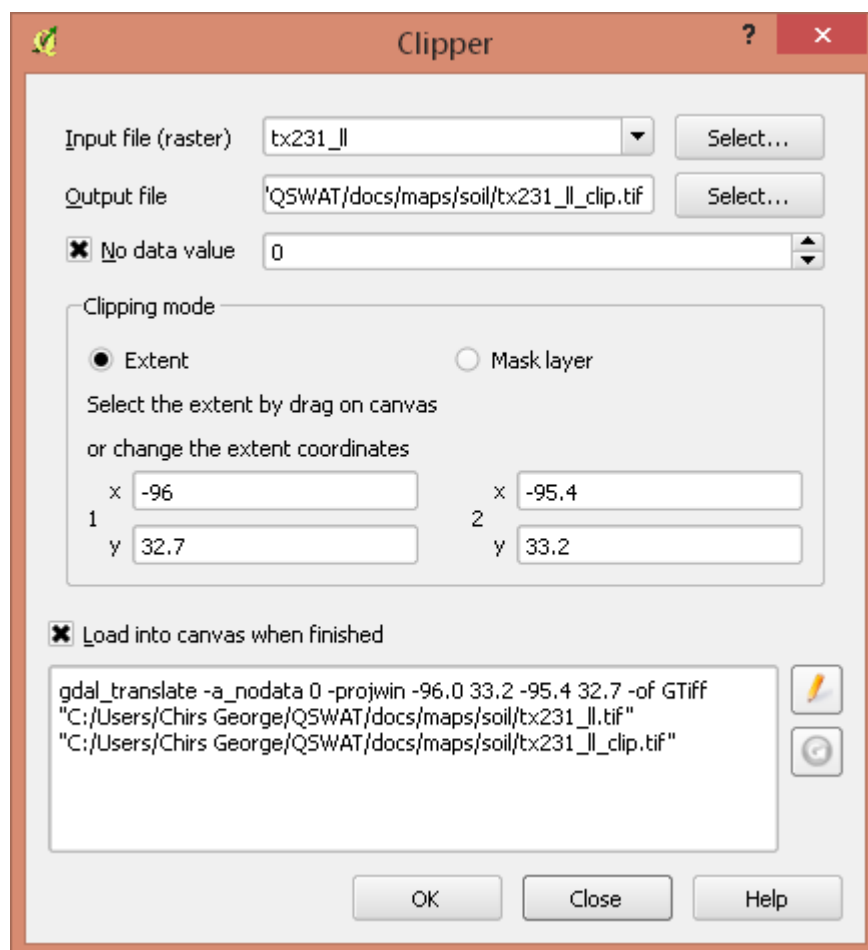


Figure 3: Clipping a soil grid

Returning to the main QGIS window we remove the unclipped grid and the shapefile.

We can now process the other soil shapefiles in the same way. We proceed as follows:

- Load the next shapefile
- Open its attribute table, toggle editing, and create the field *MUKEYINT*. You will find that the

expression `toint("MUKEY")` is already saved under *Recent (fieldcalc)* and clicking on it twice will place it in the *Expression* box. Click *OK* to close the *Field calculator*, toggle editing, confirm the save and close the attribute table.

- The *Rasterize* form should already be open, and should show the right shapefile (as there is only one loaded). The output file name is still the previous one, but you can make the minor edit for the new file within the box. The resolution is unchanged. Unfortunately, the form does not register the new field *MUKEYINT*, and only shows the field *SPATIALVER*. However, it is possible to directly edit the GDAL command in the box below. Click the *Edit* button beside the box, change *SPATIALVER* to *MUKEYINT*, and click *OK*. Do not click the *Edit* button until after clicking *OK* or it will restore the wrong field name. Click *OK* to remove the next two messages and again do not close the *Rasterize* form.
- Return to the *Clipper* form. Select the new grid as the input file, edit the output file name and leave the remainder unchanged. Click *OK*, and click *OK* to close the following two messages.
- Remove the shapefile and unclipped grid.

After closing the *Clipper* and *Rasterize* forms you should be left with a number of grids which together cover the extent.

6 Merging grids

The next task is to merge the grids. Use *Raster* → *Miscellaneous* → *Merge* to open the *Merge* form (Figure 4). Click *Select* beside *Input files*, navigate to the soil folder, hold down *Ctrl* and select each of the `_ll_clip.tif` files. Click *Open*. Click *Select* beside *Output file* and type a file name such as `soil_ll`. Check the type is *GeoTIFF* and click *Save*. Back in the *Merge* form check *No data value* and leave the value as 0. If necessary check *Load into canvas when finished* and click *OK*. Click *OK* to close each of the two messages. Close the *Merge* form.

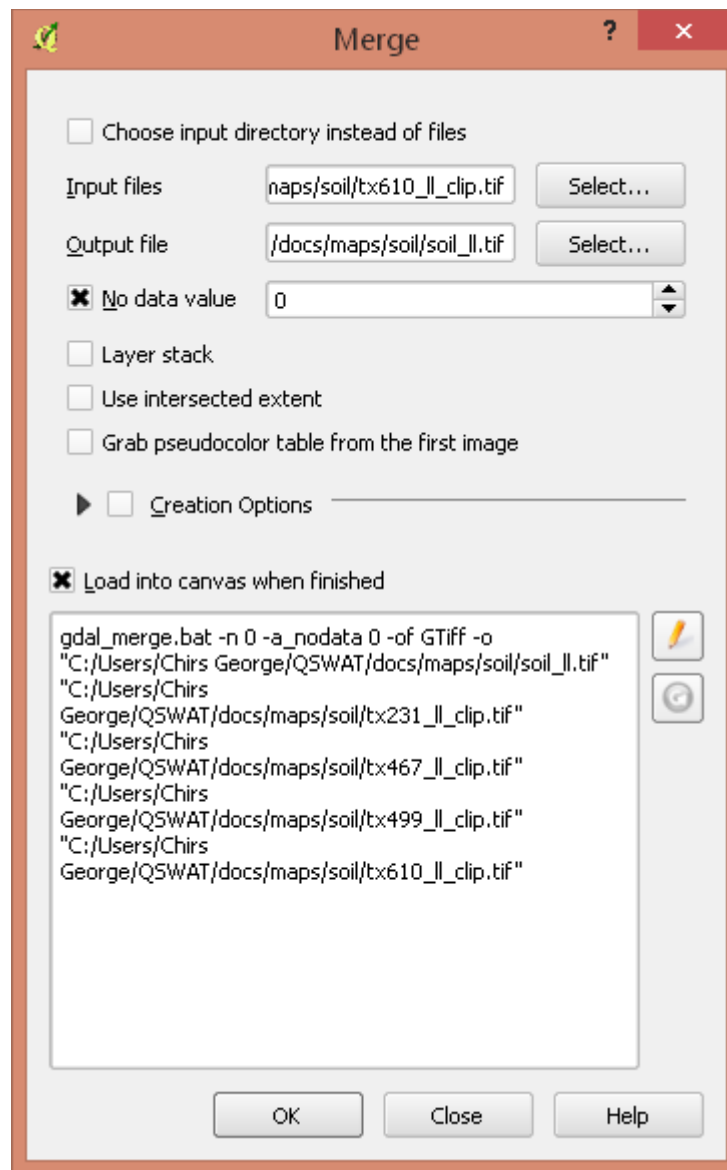


Figure 4: Merging the clipped grids

7 Reprojecting the grid

In QGIS maps can be reprojected by saving in the new projection. We will save this grid in the Albers Equal Area projection used for SWAT's Example1. We have previously loaded some of the files distributed for this example, so QGIS will have stored the projection as one recently used.

Right click on the entry for soil_ll in the *Layers* panel, and select *Save As...* to open the *Save raster layer as...* form. Browse to the soil folder, and type a suitable name, say soil_aea. Click on *Change* beside *CRS* to bring up the *Coordinate Reference System Selector* form (Figure 5). Find and select the relevant entry, and check it appears in the *Selected CRS* box at the bottom. Click *OK*. Back in the *Save raster layer as...* form click *OK* to complete the save. The grid will not be loaded because its projection is different from the current QGIS instance. You can start another instance of QGIS and load it to check it is as expected. Start QGIS and load the grid. The colouring is very inadequate, as we mentioned earlier. This will improve when we use it in QSWAT, but in general with SSURGO there

will be too many discrete soil values for effective colouring.

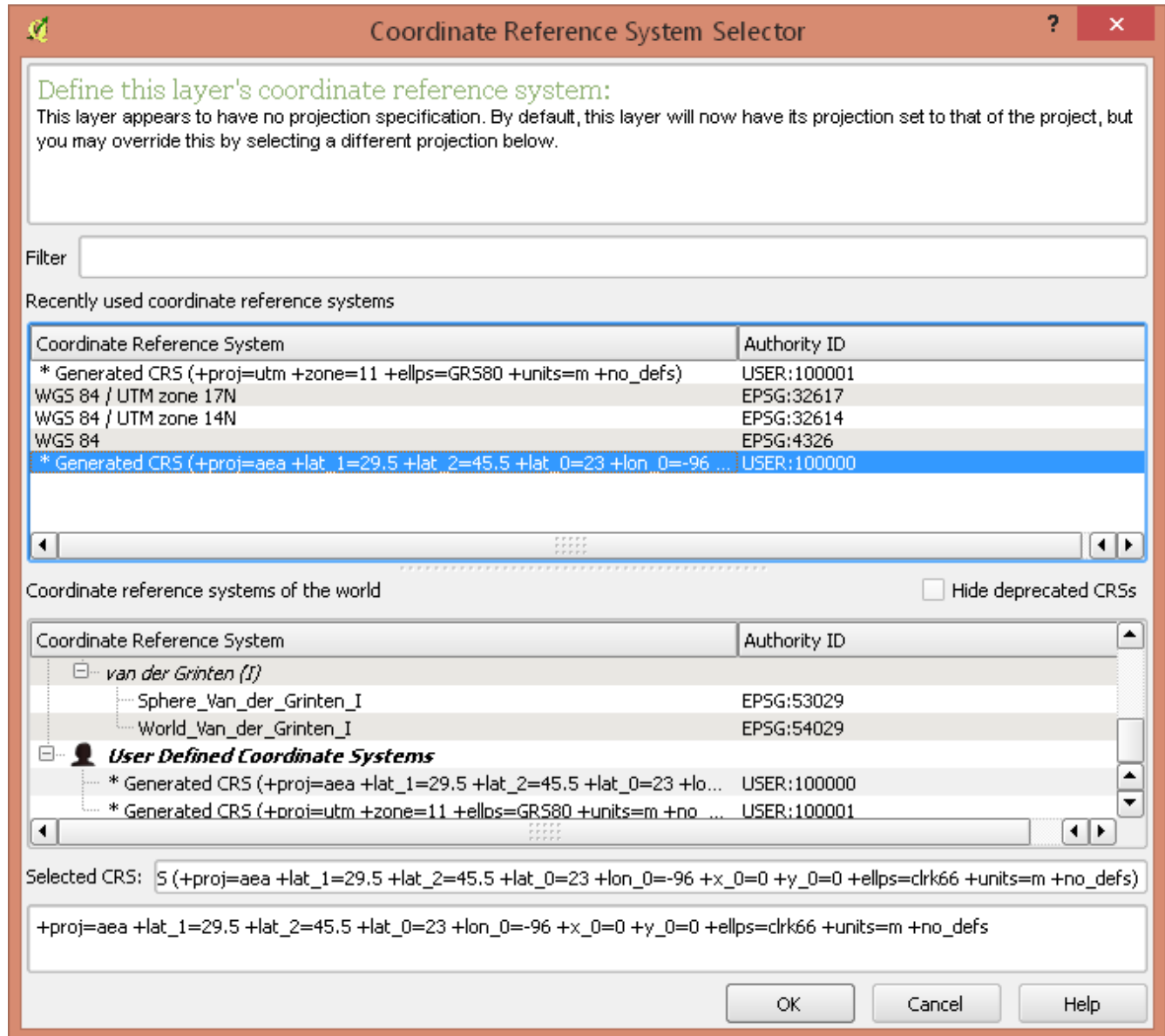


Figure 5: Selecting the coordinate reference system

8 SSURGO/STATSGO2 soil database

SWAT will need the data for the soils. SSURGO and STATSGO2 use the same database *SWAT_US_SSURGO_Soils*, which must be downloaded from the SWAT website. Currently it is stored on the ArcSWAT page <http://swat.tamu.edu/software/arcswat/>. Extract the mdb file from the zip archive and place it in the *Databases* subfolder of the SWAT Editor folder, normally *C:\SWAT\SWATEditor*. Then QSWAT will find it and pass it to the SWAT Editor for generating the soil input files.