# Using SSURGO soil data with QSWAT and QSWAT+

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Version 3

#### 1 Introduction

SSURGO soil data for the USA is available free from the web. It is a good, detailed source of soil data to use with QSWAT, but it needs some preparation first. This document explains how to obtain and prepare SSURGO 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 when it is projected. We proceed as follows:

- Start QGIS and load your DEM. If it is not projected, reproject into an equal area projection. A common projection for SWAT projects in the US is an Albers equal area, e.g EPSG:5069 or EPSG:5072
- Right click on its entry in the Layers panel, and select Save as....
- The current resolution in metres, horizontal and vertical, is shown in the *Resolution* box. The two values should be the same we want pixels to be square. If these are not the same or very close, then do the save with the same value (the minimum of the two would be a good choice) in each box..
- Unless you needed to save, just *Cancel*.

### 3 Obtaining the SSURGO maps

It is convenient to start at the USDA's Geospatial Data Gateway <u>http://datagateway.nrcs.usda.gov/</u> From there we select *Order by entering Latitude/Longitude 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.

Once you have input the extent, click *Check Desired Coordinates* to see the area you have selected, and revise if necessary to cover your watershed. 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 we are offered a *Gridded Soil Survey Geographic (gSSURGO) by State or Conterminous U.S., 1 map.* This is the one we want. If you need more than one, select all the gSSURGO maps you need. Click *CONTINUE*, and again on the next page.

On the next page you enter your email 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.

Opening a zip archive shows there is a text (.txt) file with information about the map, a user guide, and another zip file. Extracting that generates a folder with the name gssurgo\_g\_tx (the last two characters

indicating the state), which contains a text file explaining that gSSURGO has superseded SSURGO and a folder named (in our case) gSSURGO\_TX.gdb. This folder is a geodatabase, and can be opened in QGIS. But, unfortunately, although the geodatabase contains a raster version of the data, QGIS cannot read it. We need to convert the data from vector format to raster. We will also, in the process, clip our soil map to the extent we need..

Start QGIS. You may like to turn rendering off, as big vector files can take some time to display: it's a checkbox near bottom right of the QGIS window. Click the *Open Data Source Manager* button (towards top right) and select the *Vector* tab and the *Directory* radio button. Select *OpenFileGDB* as the *Type* and browse to the gSSURGO\_TX.gdb directory. Click *Add* and you are presented with a list of vector layers. The one you want has the layer name MUPOLYGON. Select it and click *OK*. Click *OK* on the select transformation form and *Close* the *Data Source Manager*. If you turned off rendering, turn the rendering of this layer off (checkbox for the layer in the *Layers* panel), and rendering for QGIS as a whole back on.

It is not currently possible in QGIS to edit geodatabase layers, so we need to save the *MUPOLYGON* layer as a shapefile. Right click on its entry in the layers panel, and select *Export -> Save Features As* (Figure 1) Select *ESRI Shapefile* as the format. Browse to a suitable directory and choose a name for the shapefile, choose the coordinate system you are using for your DEM. The only attribute we need is *MUKEY* so to speed things up a little we check only that one. Check *Extent*, click *Calculate from Layer* and select the DEM layer. Click *OK*.

The new shapefile layer is created and added. Shapes that have some part within the extent of the DEM are continued outside: this does not matter (Figure 2).

It is worth noting for future reference that this *Save as* feature of QGIS is the easiest way to reproject and/or clip both raster and vector files in QGIS.

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Figure 1: Saving the soil layer as a shapefile

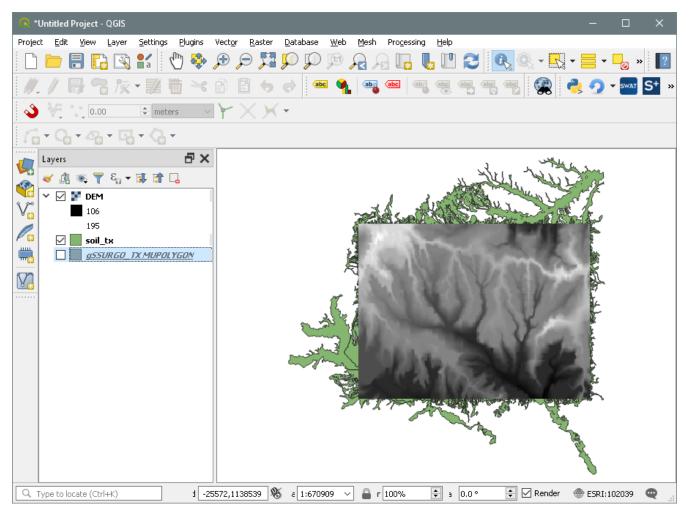


Figure 2: Soil shapefile saved and loaded

#### 4 Converting shapefiles to grids

QSWAT uses grids for soil data. It would be possible to use shapefiles, but reading them point-bypoint as we need to do is slower than for grids, so it is worth converting them once.

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

- converting from shapefiles to grids
- if necessary, merging grids

The value we want for the grid (or raster) is *MUKEY*, but unfortunately it is stored as a string. There is a simple procedure to generate an equivalent numeric field. Right click on the layers panel entry for the soil shapefile, and *Open Attribute Table*. Click on the *Field calculator* (4th from the right end). In the *Field calculator* form (Figure 3) 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 to\_int("MUKEY"). You can simply type this in the *Expression* box, or you can create it by clicking in the central panel:

• Expand *Conversions* and double click *to\_int*.

- Expand Fields and Values, and double click MUKEY.
- In the Expression panel, click on the button containing ) (or just type it).

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Figure 3: Field Calculator

Click *OK* and wait for the Field Calculator to close. You will see in the attribute table the new attribute *MUKEYINT* has been added and the values inserted. The editor is in editing mode, so click the *Toggle Editing Mode* button (top left), click *Save* when prompted, and close the editor

We are now ready to convert to a grid. Use *Processing -> Toolbox -> SAGA -> Raster creation tools - > Rasterize* to open the *Rasterize* form. Select the input shapefile, which will be available in the pull down menu, set the *Attribute field* to *MUKEYINT, Method for Multiple values* to *first, Method for Lines* to *thin*, second one to *cell*, *Preferred Target Grid Type* to *Integer (4 byte)*, ignore *Output extent*, use the number we got earlier for the DEM's cell size for *Cellsize, cells* for *Fit*, and for *Rasterized* click the button on the right, browse to a suitable directory and choose a suitable file name (Figure 4) The output will be a Saga raster, with extension *.sdat*, which is fine. Click *Run*. Click closed when finished. The result will probably look mostly black, because of the default grey scale colouring (Figure 5).

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Figure 4: Rasterize form

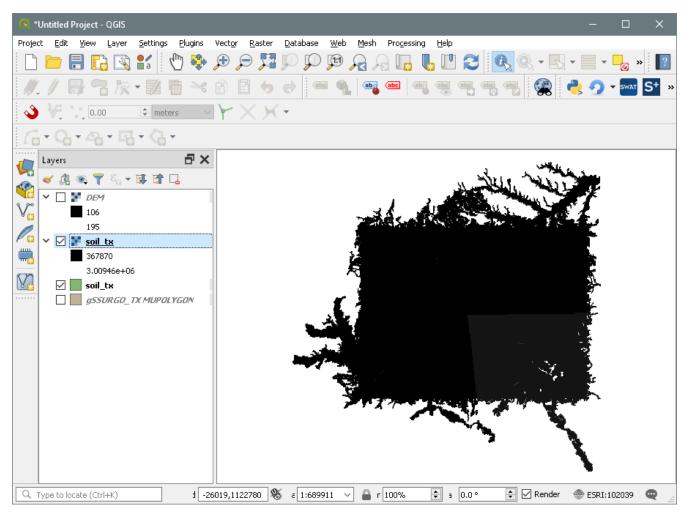


Figure 5: Soil raster created

### 5 Merging grids

If your watershed included area from more than one state you will have grids to merge. Use *Processing -> Toolbox -> SAGA -> Raster tools -> Mosaic Raster layers* to open the *Mosaic* form. Click the right button under *Input layers*, check the grids you want to merge, and select *4 byte* signed *integer* as the *Preferred data storage type*. Use *cells* for *Fit* and leave the rest as their defaults. Under *Grid* browse to a suitable directory, and choose a suitable file name. Click *Run* (Figure 6).

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Figure 6: Merging grids

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# 6 SSURGO soil database

SWAT will need the data for the soils. This is found in the database *SWAT\_US\_SSURGO\_Soils*, which must be downloaded from the SWAT website. Extract the mdb file from the zip archive and place it in the *Databases* subfolder of the SWAT Editor folder. QSWAT will find it and pass it to the SWAT Editor for generating the soil input files.

SWAT+ uses sqlite databases, and the SSURGO tables are in C:\SWAT\SWATPlus\Databases\swatplus\_soils.sqlite.