Data Pre-Processing for SWAT

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Introduction

This document will assist a user in the pre-processing of data to be used in the Soil and Water Assessment Tool (SWAT). There are four main data files that SWAT requires: Digital Elevation Model (DEM) data, landuse data, soil data, and weather data. There are many more datasets that can be used as input to SWAT but they are optional. The purpose of this document is to provide a new SWAT user with the steps necessary to get data for a specific watershed and pre-process the data so that it is ready to be run with SWAT. The user should know that the data used in these examples is convenient but most likely not the best data for all applications.

1. Software: Map Window GIS

Download and install the latest stable release version of Map Window GIS. This software allows user to easily manipulate data to the formats required by MWSWAT.
http://www.mapwindow.org/downloads/index.php?show_details=1

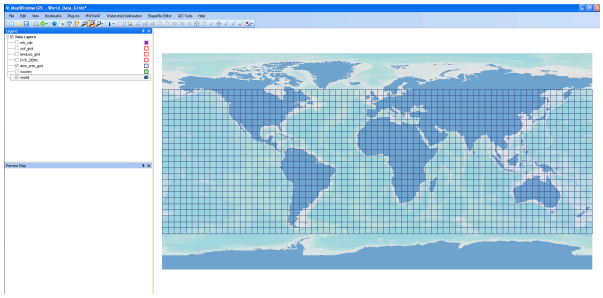
2. Load World Data Grid

This map is the layout for UTM projected data. Throughout the processing of data the UTM projection will be used. In some cases, data will need to be assigned this projection or reprojected to match UTM.

a. Download the zip file of World Data Grids
http://www.waterbase.org/download_data.html

b. Unzip the file and Open World Data Grids 

by double clicking the icon.



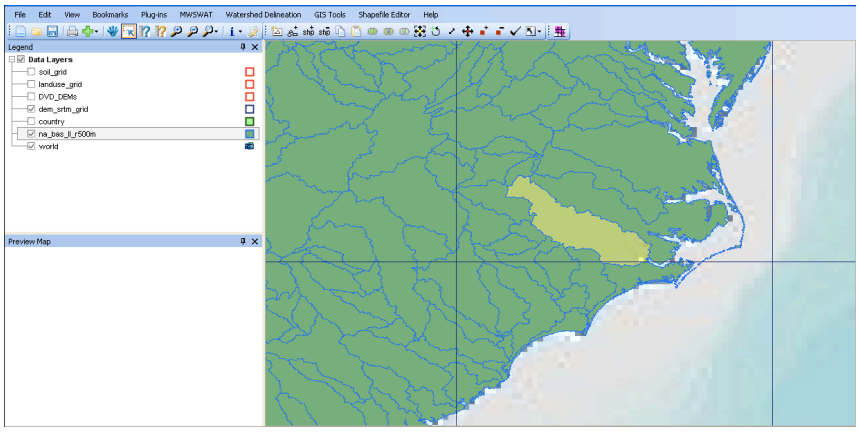
3. Determine Region of Interest

If you have a specific watershed that you would like to model, you can locate it using the resource in part a below (skip to 3.a if this describes your preference). This example uses a specific watershed for the region of interest. If you want to hand draw a region, turn off the data layers in the map window by unchecking the boxes next to each name except the one that is most useful to you (most likely the country layer will be helpful). Zoom  in to a level where you can easily draw your region. Continue with step 3.c where the new shapefile is created.

a. Download the Global River Basin Shapefile for your region of interest.
http://www.waterbase.org/download_data.html
The files are divided by continent. Unzip the file once downloaded.

b. Adding Data

Add the river basin file to your map window by clicking on  and navigate to the folder the file is saved in and select the shapefile to load. A projection warning will appear and in most cases, including this one, you will want to have the new layer reprojected to the current map window's projection. If you do not see the new layer, drag it to the top of the legend list so it is visible. Turn off any unwanted layers. Zoom in to your watershed region so that you can still see the entire boundary of your watershed. If you want to highlight your watershed, use the  tool and click inside the area of your watershed.

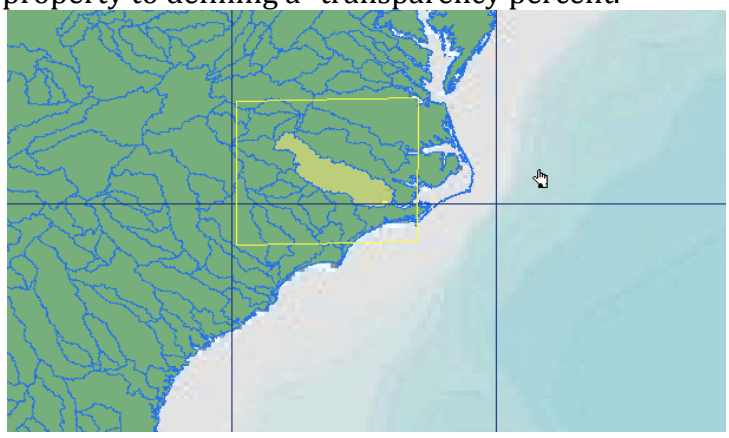


c. Create a New Shapefile

Only complete this step if you are not using the predefined watershed boundary file in part 3.a. Under the Plug-Ins menu, select Shapefile Editor to turn on the toolbar. Create a new shapefile using  . Change the shapefile type to polygon and click OK. You now have a shapefile for your watershed. Next, draw your watershed. To create your watershed's boundary you may use  or  to add a shape. The former will allow you to draw your shape by clicking to create the vertices (straight lines will connect your points). To complete your shape, make sure it is a closed polygon and double click. The second option will allow you to add a predefined shape (circle, polygon, ellipse) by defining the size.

d. Create a Watershed Boundary Clipping File

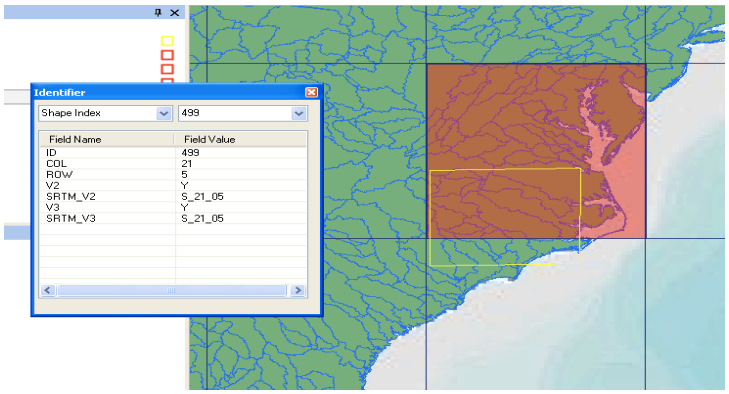
Create a square region around your watershed for clipping data. First, create a new shape file of type polygon (see section 3.c) and title it including the term "clip" so you know this is the file to use when clipping datasets. In this example we will call the new file square_clip. Leave ample room around your watershed because you do not want to clip it too close and end up with missing data at the boundary for future, lower resolution, layers that you clip. Once the new layer is added to the window, you can adjust its transparency if you wish in order to see the layers underneath. To do this, right click on the layer in the legend and select Properties. There are various options ranging from turning off the "show fill" property to defining a "transparency percent."

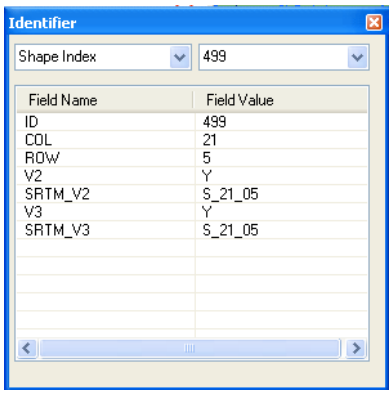


4. Determine the UTM Zone Location of your Watershed

a. Identifying

Identify the grid(s) where your watershed is located. Make sure your dem_srtm_grid layer is selected under Data Layers. Identify  and then click inside one gridbox at a time. The SRTM value is what you want to record. Continue to select any other gridboxes that the square_clip touches.





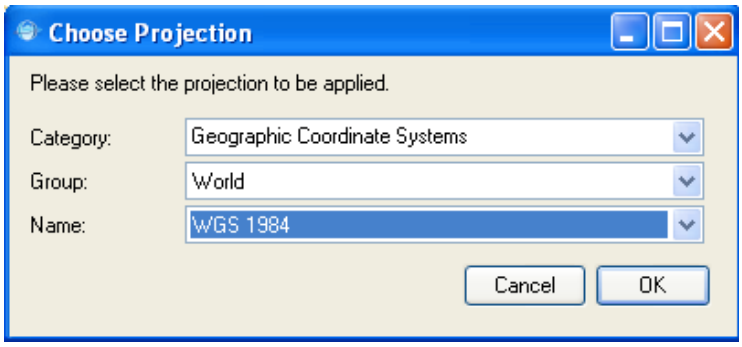
b. This box label is not the actual UTM zone but it is still important to remember. The UTM zone (http://en.wikipedia.org/wiki/File:Utm-zones.jpg) can be determined by finding the vertical column that the watershed resides in. Record this value and if it is in the northern or southern hemisphere.

5. Pre-process DEM data

a. Use this site http://srtm.csi.cgiar.org/SELECTION/inputCoord.asp to download DEM data. First change the third selection option to ArcInfo ASCII format and then select the gridboxes on the map that encompass your watershed. Confirm they are correct by checking the result for Tile X and Tile Y in the second section for Data Selection Method. Tile X and Tile Y should correspond to your boxes identified in step 4.a. Once all required boxes are selected, click the yellow box to begin your search and download the data from the CSI server.

b. Reproject the square clip

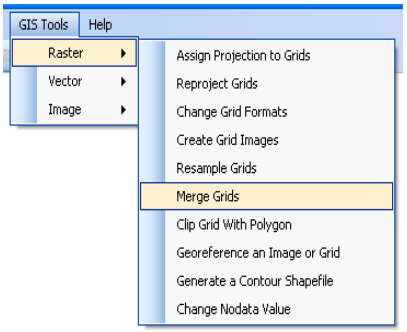
In preparation for applying the clip to the DEM layer, the clip must first be reprojected to match the projection of the DEM. Turn on GIS Tools by selecting Plug-Ins - GIS Tools. Make sure the clip layer is selected in the legend. Go to GIS Tools, Vector, Reproject a Shapefile. Select the square_clip. Use the following projection settings:



Select OK. DO NOT ADD IT TO THE MAP because the map is a different projection. Restart MapWindow.

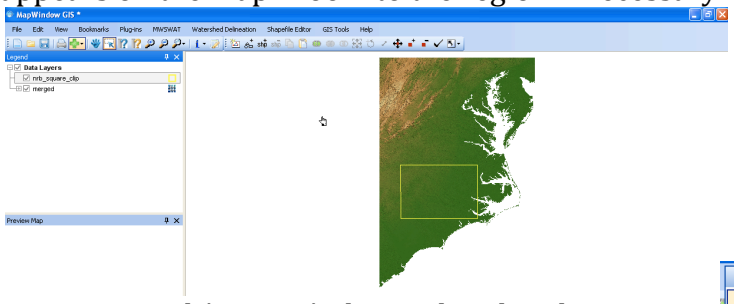
c. Merge gridboxes

If your watershed lies in only one UTM gridbox, simply skip to part 5.d. In a new MapWindow project, add the DEM data one gridbox at a time. These files are very large and can take a long time to load. Under the Plug-ins menu dropdown, turn on GIS Tools and it should then appear along the top menu bar of Map Window. In order to clip the region using square_clip, the gridboxes must first be merged into one file. To do this, go to GIS Tools\Raster\Merge Grids. Add the files one at a time for the gridboxes you need to merge. To add more use  . When finished, click OK. Keep the output format ASCII, name, and click Finish.

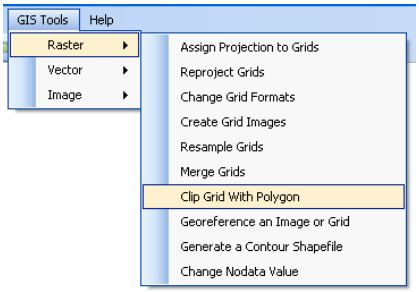


d. Clipping

First, clear all layers and then load the new, merged layer. Next we will clip this layer to our square_clip shapefile created earlier, which outlines the watershed. Load the square_clip layer as well and drag it to the top of the list so that it appears on the map. Zoom to the region if necessary.



Go to GIS Tools\Raster\Clip Grid with Polygon. Leave "Clip to Extents (Fast)" unchecked. Click "Select Shapes" and select the box shape outlining the region. Click "Done" and "OK". Close Map Window and do not save.



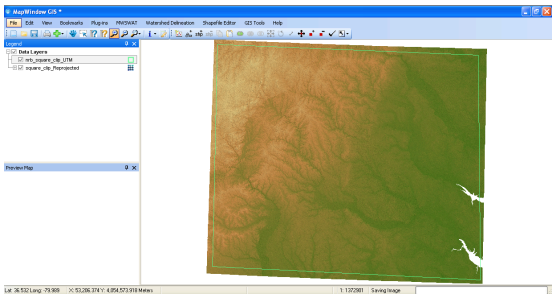
6. Re-Project to UTM Coordinates

MWSWAT requires that the input files be in meter units and equal area projection so we must re-project the files. MWSWAT developers typically use UTM coordinates. Although UTM is not technically equal area projection, it is sufficiently close for reasonably sized watersheds. This includes the DEM UTM file that we will ultimately save and the clipping files so that we can re-clip the DEM to remove any missing values from the re-projection.

a. Restart Map Window (one of the purposes of quitting and restarting Map Window is to clear the projection memory) and add the clipped DEM. Go to GIS Tools\Raster\Reproject Grids, add the layer, and click OK.
   i. Category: Projected Coordinate Systems
   ii. Group: Utm – Wgs 1984
   iii. Name: WGS 1984 UTM Zone ## (this is the zone that you found earlier in step 3d.
   iv. Click OK. DO NOT ADD NEW LAYER TO MAP BECAUSE PROJECTIONS ARE DIFFERENT!
   v. Close Map Window.

b. To check that our re-projected map is correct, we will re-project our watershed and layer the datasets to confirm geographic locations.
   i. Open the watershed shapefile and go to Tools\Vector\Assign Projection to Shapefile
      1. Select the watershed file
         a. Category: Geographic Coordinate Systems
         b. Group: World
         c. Name: WGS 1984
   ii. Add this watershed layer to the DEM UTM layer and it will ask if you want to re-project the watershed to match the DEM UTM. Allow it to perform the re-projection and it will save a new file called watershed_name_reprojected. Load this layer and confirm that the DEM UTM is in the correct geographic location.
   iii. Close Map Window.

c. Repeat steps 5b i-iii for square_clip so that it is manually converted to WGS 1984 and then add to the DEM UTM map and select to re-project to map projection. Rename square_clip_reprojected to square_clip_UTM so the projection is documented.



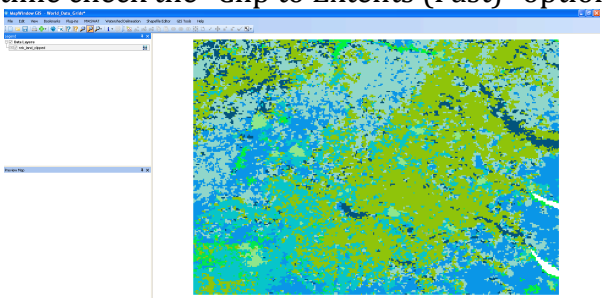
d. Clip the DEM UTM using the square_clip_UTM file so that any missing values are eliminated.

7. Save MWSAT input File

Save the new clipped DEM UTM file and watershed UTM file in a way that indicates they will be used with MWSWAT. Example: DEM_utm_SWAT

8. Pre-process Land Use Data

a. Download land use data for your region of interest. http://www.waterbase.org/download_data.html
b. In a new Map Window project, load World Data Grids and turn on landuse_grid. If you are unsure where you watershed is located, also load your watershed shapefile. Determine which landuse box your watershed is located within. Close and then open a new Map Window project and load the landuse TIF image that corresponds to the landuse box number.
c. Follow the instructions in 4c to clip the landuse map with square_clip but this time check the "Clip to Extents (Fast)" option.



d. Re-project the clipped landuse data to UTM using instructions 5a. Check the geographic location by loading square_clip_UTM.
e. Clip landuse_UTM with square_clip_UTM.
f. Save landuse_clipped_UTM as land_utm_MWSWAT.

9. Pre-process Soil Data

a. Download soil data for your region of interest. http://www.waterbase.org/download_data.html
b. Repeat instructions in step 7 with soil data.

10. Weather Data

If you have weather data that you would like to incorporate into SWAT in order to obtain the most realistic simulation, there are a few necessary steps in formatting the input files. SWAT will accept temperature (degree C), precipitation (mm/day), wind speed (m/s), solar radiation (MJ/m^2), relative humidity (fractional), and potential evapotranspiration (mm H_2O) weather inputs. Specific units for these variables must also be followed.

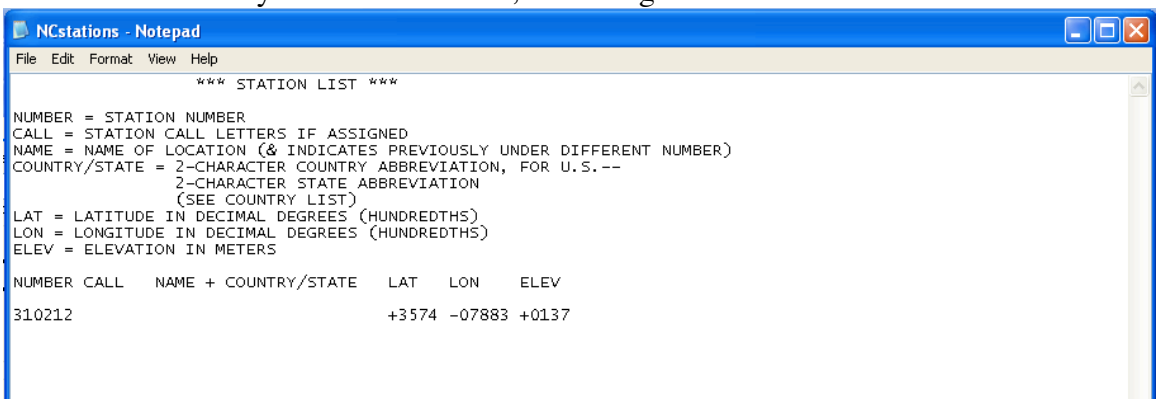
a. Create a text file of weather location/station information

You must know the exact location of where your weather data was collected. It is also very important that the exact file formatting is followed. This file contains the latitude, longitude, and elevation of the weather station and each station must have a six digit ID. You may create the ID if your station was not initially assigned one. The following is copied out of "Map Window Interface for SWAT" from page 67:

"First make a .txt file called any name you choose, e.g. *stations.txt*…It may have any number of header lines followed by one or more station lines. The first 6 characters of a station line must be decimal digits (and the first 6 characters of a header line must not be all decimal digits). These six digits form the station identifier. Each station line must also have (numbering the first, leftmost position as 1):

- A latitude in positions 38-42 inclusive, starting with a + or – sign in position 38, followed by 4 decimal digits representing a latitude in hundredths of a degree.
- A longitude in positions 44-49 inclusive, starting with a + or – sign in position 44, followed by 5 decimal digits representing a longitude in hun dredths of a degree.
- An elevation in positions 51 -55 inclusive, starting with a + or – sign in position 51, followed by 4 decimal digits representing an elevation in metres.

The station lines may contain other data, but it is ignored."



b. **Create individual files for each weather station and variable**

Place these files in the same folder as your stations file. (best if these files are in the folder of your MWSWAT project) The following is taken from "Map Window Interface for SWAT" from page 67:

"In the same folder as *stations.txt* may be placed files *nnnnnn.pcp*, *nnnnnn.tmp*, *nnnnnn.slr*, *nnnnnn.hmd*, *nnnnnn.wnd* with precipitation, temperature, solar radiation, relative humidity and wind speed data respectively, where *nnnnnn* is the identifier of a station in *stations.txt*…The structure of each of these five file types is as follows:

- The first line can contain any text: it is ignored.
  For *.pcp* and *.tmp* only:
  i. The second line has the string "Lati" in positions 0 -3 and a latitude in degrees expressed as a decimal number, o ptionally starting with a – sign, in positions 8-12 for *.pcp*,13-17 for *.tmp*.
  ii. The third line has the string "Long" in positions 0 -3 and a longitude in degrees expressed as a decimal number, optionally starting with a – sign, in positions 8-12 for *.pcp*,13-17 for *.tmp*.
  iii. The fourth line has the string "Elev" in positions 0 -3 and an elevation in degrees expressed as a decimal number, optionally starting with a – sign, in positions 8-12 for *.pcp*,13-17 for *.tmp*.
- The following lines all have the date in Julian form (4 -digit year followed by 3-digit zero-filled day) in columns 1-7. The date is followed by one or two numbers as follows

i. For *.pcp*: the precipitation for that day in mm in the form xxx.x in positions 8 - 12
ii. For *.tmp*: the maximum and minimum temperatures for the day in °C, each in the form xxx.x, in positions 8 -12 and 13-17 respectively.
iii. For *.slr*: the solar radiation for that day in MJ/m2 in the form xxxx.xxx in positions 8-15.
iv. For *.hmd*: the relative humidity for that day as a fraction in the form xxxx.xxx in positions 8-15.
v. For *.wnd*: the wind speed for that day in m/s for in the form xxxx.xxx in positions 8-15.

- The dates in all files must be the same, and within each file must be sequential days."