Step by Step Geo-Processing and Set-up of the Required Watershed Data for MWSWAT (MapWindow SWAT)

By Luis F. Leon Version 2 October 2011

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1 Source Data

1.1 DEM Source Data

1.1.1 SRTM Processed 90m Digital Elevation Data Version 3:

Format: GeoTiff Grid Files in 5° x 5° tiles (Lat/Long, decimal degrees) Source: <u>http://srtm.csi.cgiar.org/</u> Metadata included in header:

Geotiff Information: Version: 1 Key Revision: 1.0 Tagged Information: ModelTiepointTag (2,3): 0 0 0 -105.000416 25.0004171 0 ModelPixelScaleTag (1,3): $0.000833333333 \quad 0.000833333333 \quad 0$ End Of Tags. Keyed Information: GTModelTypeGeoKey (Short,1): ModelTypeGeographic GTRasterTypeGeoKey (Short,1): RasterPixelIsArea GeographicTypeGeoKey (Short,1): GCS WGS 84 GeogCitationGeoKey (Ascii,7): "WGS 84" GeogAngularUnitsGeoKey (Short,1): Angular Degree End Of Keys. End Of Geotiff.

GCS: 4326/WGS 84 Datum: 6326/World Geodetic System 1984 Ellipsoid: 7030/WGS 84 (6378137.00,6356752.31) Prime Meridian: 8901/Greenwich (0.000000/ 0d 0' 0.00"E)

PROJ.4 Definition: +proj=latlong +ellps=WGS84 +to_meter=1.0000000000

Contents of the Readme file:

PROCESSED SRTM DATA VERSION 4.1

The data distributed here are in ARC GRID, ARC ASCII and Geotiff format, in decimal degrees and datum WGS84. They are derived from the USGS/NASA SRTM data. CIAT have processed this data to provide seamless continuous topography surfaces. Areas with regions of no data in the original SRTM data have been filled using interpolation methods described by Reuter et al. (2007).

Version 4.1 has the following enhancements over V4.0:

- Improved ocean mask used, which includes some small islands previously being lost in the cut data.

- Single no-data line of pixels along meridians fixed.
- All GeoTiffs with 6000 x 6000 pixels.
- For ASCII format files the projection definition is included in .prj files.
- For GeoTiff format files the projection definition is in the .tfw (ESRI TIFF
- World) and a .hdr file that reports PROJ.4 equivelent projection definitions.

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ACKNOWLEDGMENT AND CITATION

We kindly ask any users to cite this data in any published material produced using this data, and if possible link web pages to the CIAT-CSI SRTM website (http://srtm.csi.cgiar.org).

Citations should be made as follows:

Jarvis A., H.I. Reuter, A. Nelson, E. Guevara, 2008, Hole-filled seamless SRTM data V4, International Centre for Tropical Agriculture (CIAT), available from http://srtm.csi.cgiar.org.

REFERENCES

Reuter H.I, A. Nelson, A. Jarvis, 2007, An evaluation of void filling interpolation methods for SRTM data, International Journal of Geographic Information Science, 21:9, 983-1008.

Downloaded Data



This guide assumes that the zipped DEM files, such as **srtm_16_08.zip** are available. These can be downloaded from <u>http://srtm.csi.cgiar.org/</u>. We use the GeoTiff format. The suggested location to prepare the clipped versions to use in MWSWAT is a temporary folder (e.g. C:\temporary\dems). Once the DEM is merged and/or clipped for the area of interest it is strongly suggested to move the resulting output grid (*filename.tif*) to the MW_project location.

1.1.2 Basic Supporting Geographic Data:

HYDRO1k Elevation Derivative Database: <u>http://eros.usgs.gov/#/Find_Data/Products_and_Data_Available/gtopo30/hydro</u> Format: ArcView Shapefile Format (Lambert Azimuthal Equal Area projection) Documentation: <u>http://eros.usgs.gov/#/Find_Data/Products_and_Data_Available/gtopo30/README</u>

Drainage Basins:

Africa - http://edcftp.cr.usgs.gov/pub/data/gtopo30hydro/af_bas.tar.gz

- Origin (Longitude = 20° E ; Latitude = 5° N)
- Asia <u>http://edcftp.cr.usgs.gov/pub/data/gtopo30hydro/as_bas.tar.gz</u>
 - Origin (Longitude = 100° E ; Latitude = 45° N)

Australasia - <u>http://edcftp.cr.usgs.gov/pub/data/gtopo30hydro/au_bas.tar.gz</u>

• Origin (Longitude = 135° E ; Latitude = 15° S)

Europe - <u>http://edcftp.cr.usgs.gov/pub/data/gtopo30hydro/eu_bas.tar.gz</u>

• Origin (Longitude = 20° E ; Latitude = 55° N)

North America - <u>http://edcftp.cr.usgs.gov/pub/data/gtopo30hydro/na_bas.tar.gz</u>

• Origin (Longitude = 100° W ; Latitude = 45° N)

South America - http://edcftp.cr.usgs.gov/pub/data/gtopo30hydro/sa_bas.tar.gz

• Origin (Longitude = 60° W ; Latitude = 15° S)

The above files are already projected in latitude-longitude and available from the WaterBase web site http://www.waterbase.org/download_data.html as Global River Basins. The vertices were also smoothed with 500m threshold. Format: ArcView Shapefile Format (lat/long)

Projected Basins:

Africa –	af_bas_ll_r500m.zip
Asia –	as_bas_ll_r500m.zip
Australasia –	au_bas_ll_r500m.zip
Europe –	eu_bas_ll_r500m.zip
North America	a – na_bas_ll_r500m.zip
South America	a – sa_bas_ll_r500m.zip



It is suggested to unzip the contents of the files to a folder in the user's hard drive (e.g. C:\unu_waterbase\Global_Basins_latlong). The above figure, with the basins in different color for each continent, was created with ArcView but a similar image can be generated with MapWindow.

1.2 Landuse Source DATA:

The landuse data was provided by Dr Karim Abbaspour of Eawag (<u>http://www.eawag.ch/index_EN</u>):

Landuse data was constructed from the USGS Global Land Cover Characterization (GLCC) database (http://edcsns17.cr.usgs.gov/glcc/glcc.html). This map has a spatial resolution of 1 kilometre and 24 classes of landuse representation. The parameterization of the landuse classes (e.g. leaf area index, maximum stomatal conductance, maximum root depth, optimal and minimum temperature for plant growth) is based on the available SWAT landuse classes and literature research.

Pre-processing note:

Due to the huge size of the uncompressed files, after importing the file with ArcView the grids were divided into tiles for each continent. The resulting files were still rather slow to load and manipulate in MapWindow, and were therefore resampled at half the original resolution. Both the original and resampled (*newres*) tiles are available from the WaterBase web site http://www.waterbase.org/download_data.html. We think that there will typically be little difference in the results from SWAT between the two resolutions. When you are starting to use MapWindow and MWSWAT we suggest you use the resampled tiles. It is possible to get much better speed with the original tiles if you hide their display before clipping, but this is likely to be confusing to new users. We give an explanation of this in the sections on generating landuse maps.

Files exported as GeoTiff raster:

- North America na_landuse.zip, na_landuse_newres.zip (na_land_1, na_land_2, na_land_3)
- South America sa_landuse.zip, sa_landuse_newres.zip (sa_land_1, sa_land_2)
- Europe & Asia ea_landuse.zip, ea_landuse_newres.zip (ea_land_1, ea_land_2, ea_land_3, ea_land_4)
- Africa af_landuse.zip, af_landuse_newres.zip (af_land_1, af_land_2)
- Australia & Pacific ap_landuse.zip, ap_landuse_newres.zip (ap_land_1)

1.3 Soil Source DATA:

The soil data was provided by Dr Karim Abbaspour of Eawag (<u>http://www.eawag.ch/index_EN</u>):

Soil map was produced by the Food and Agriculture Organization of the United Nations (FAO, 1995). Almost 5000 soil types at a spatial resolution of 10 kilometres are differentiated and some soil properties for two layers (0-30 cm and 30-100 cm depth) are provided. Further soil properties (e.g. particle-size distribution, bulk density, organic carbon content, available water capacity, and saturated hydraulic conductivity) were obtained from Reynolds et al. (1999) or by using pedotransfer functions implemented in the model Rosetta (http://www.ars.usda.gov/Services/docs.htm?docid=8953).

Reynolds, C.A., Jackson, T.J., Rawls W.J., 1999. Estimating available water content by linking the FAO soil map of the world with global soil profile database and pedo-transfer functions. Proceedings of the AGU 1999 spring conference. Boston, MA.

The soil data is available from the WaterBase web site <u>http://www.waterbase.org/download_data.html</u>

Files exported as GeoTiff raster:

- North America na_soil.zip (na_soil_1, na_soil_2, na_soil_3)
- South America sa_soil.zip (sa_soil_1, sa_soil_2)
- Europe & Asia ea_soil.zip (ea_soil_1, ea_soil_2, ea_soil_3, ea_soil_4)
- Africa af_soil.zip (af_soil_1, af_soil_2)
- Australia & Pacific ap_soil.zip (ap_soil_1)

1.4 Loading GeoTiffs

MapWindow can load GeoTiff grids as grids or as images. Before you start, check that you are set up to load them as grids, so that they can be processed. Use *Project -> Settings -> Application Settings* and if necessary change *TIFF/IMG/DEM Loading Behavior* to **LoadAsGrid**. If you changed the setting, exit and restart MapWindow so that your preference is saved.

1.5 Note on Projection Warnings

Sometimes when adding a layer to MapWindow you may see a warning like the following:

Projection absence	
Layer projection isn't specified. Choose the way how to handle it:	
Assign projection from project	
Ignore the absence	
Skip the life	
Use this answer for the rest files	Ok
Never show this dialog	
	Lancel

This is because one of the maps already added has projection information, which has set the current project projection, and the new map does not. To be safe you can select *Skip the file*, and use *Project\Settings* to look at the *Project Projection*. For a lat/long projection this should say (for the maps we are using) Lat/Long for the Map Data Units and WGS 1984 for the ProjectProjection. For a UTM projection it should say (again for the maps we are using) Meters for the Map Data Units and UTM Zone plus either 14, Northern Hemisphere (for San Juan) or 36, Southern Hemisphere (for Linthipe). Provided the new layer is intended to be lat/long or UTM respectively you can select the default action of *Assign projection from project*. This does not change the layer data, it merely stores an extra .prj file for the layer being added (and prevents any similar warnings for this map in future). If you take this default action, a second window shows the maps for which projections have been assigned, which you can *Close*:

Filename	Initial projection	Operation	New filename
world.jpg	none	Assigned	
country.shp	none	Assigned	
dem_srtm_grid.shp	none	Assigned	
soil_grid.shp	none	Assigned	
landuse_grid.shp	none	Assigned	

If you are adding a new layer that has a different projection from the current project projection, for example as the result of reprojection, then you get a similar warning titled *Projection mismatch*. In this case the best thing to do usually is *Skip file*, then clear all layers (which removes the current project projection) before adding the differently projected layer.

1.6 Selecting a UTM zone

To select a UTM zone for anywhere in the world, you can use the map at <u>http://www.dmap.co.uk/utmworld.htm</u>. Alternatively, if you have a longitude of x° in the center of your watershed, taking E as positive and W as negative, then the zone is (x + 180)/6 rounded up to the next integer, plus N if the location is north of the equator, S if it is south. For example, San Juan is about 99°W so we take x as -99, (-99+180)/6 = 13.5, which rounds up to 14, and our UTM zone for San Juan is 14N. Linthipe is around 34°E, and (34+180)/6 \approx 35.7, giving UTM zone 36S.

2 Setup for Mexico: San Juan River Watershed2.1 Elevation maps (DEMs)

2.1.1 Pre-Process of DEM Data

Objective: Merge and clip the SRTM files for the area of interest.

As an alternative to the derivative basins files, the users may have available their own map data for the region. In this example, there are additional datasets for watersheds, surface water (i.e. lakes and dams) and rivers for the San Juan River watershed. (additional shape files: **sj_washd_ll, sj_water_ll & sj_rivers_ll**; all in lat/long).

Clip DEM for Area of Interest:

 Unzip World_Data_Grids.zip (available from the WaterBase web site <u>http://www.waterbase.org/download_data.html</u>) and use MapWindow to open the project file World_Data_Grids.mwprj.



- Add the following layers . Global_Basins_latlong\na_bas_ll_r500m.shp (lat/long basins) and SJ_Maps\sj_washd_ll.shp (user watershed file, just for reference purposes).
- Zoom in to the required level and create a shape file with a rectangle around the area of interest (namely the shape file SJ_Maps\sj_clip_box_ll.shp). To make such a rectangle, first select the *Shapefile Editor* from the *Plug-ins* menu. Then:
 - 1. Use \bowtie to open a new shapefile.
 - 2. Set its name to **SJ_Maps\sj_clip_box_ll.shp** and its type to *Polygon* and click *OK*. If you get a warning about no projection, click *OK* to take the default action of setting the new shapefile's projection to the project projection.
 - 3. Click OK on the warning about the extents of the new shapefile.
 - 4. Use to add a regular shape, select Rectangle, set the width and height to 1 (which means 1 degree, since the project is in lat/long), click somewhere near the center of the watershed to place the initial rectangle, and click *Done* to stop adding shapes.
 - 5. Before adjusting the rectangle to cover the watershed, set the *Transparency* for the shapefile to some intermediate figure, say 150. To do this, use the right mouse button on the legend entry for sj_clip_box_ll, select *Properties*, and then the Appearance tab. Change the *Transparency* value and click *Apply* and *OK*.

This allows the watershed shape to be seen through the rectangle. Click on to go into selection mode, click on the rectangle, and then Click on to move the vertices of the initial rectangle one by one so that it easily includes the watershed. The next two pictures show (a) the situation after moving the first vertex and (b) the situation after moving all four vertices.





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• With the **dem_srtm_grid** active, identify Identify the four DEM files that needed to be clipped and merged (S_16_08, S_16_09, S_17_08 & S_17_09).

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- Exit from MapWindow: do NOT save the changes to the project.
- Unzip srtm_16_08.tif from srtm_16_08.zip, store it in temporary\dems and add it as a layer. Also add the shapefile SJ_Maps\sj_clip_box_ll.shp.
- Use *Toolbox**Raster**Clip Grid With Polygon*. Select the dem grid to clip and the box shapefile to clip with.
- Check the *Clip to Extents (Fast)* and *Add Results to Map* options, click *Select Shapes* and select the shape (clip box). Click *Done* when the box is highlighted (yellow). Note that the output file name is created for you (keep this default name and location: temporary\dems\ srtm_16_08_clip.tif). Click *OK* to clip.

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				MapWinGIS 4.8
1 shape selected. Click OK to clip.		3		

- When the clipping is done, remove the large dem layer (srmt_16_08.tif) and repeat the process for the other three tiles (srtm_16_09.tif, srtm_17_08.tif & srtm_17_09.tif). Don't forget to remove them from the view after clipping, leaving only the clipped files.
- Merge the four clipped grids with *Toolbox\Raster\Merge Grids*. It is possible to merge all four in one step, but this often leaves strips of NoData cells at the joins. It is safer to merge two at a time. We start by merging srtm_16_08_clip.tif and srtm_17_08_clip.tif. Select these two clipped grids (press Ctrl while selecting) and click Open.

Open grid files	;				? 🛛
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My Network	Files of <u>type</u> :	All supported formats		▼	Cancel

 \circ $\;$ When done, the Select Grids window will display the information for each of the files.

# Select Grids					?×
Filename	Size (kB)	Data Type	Cell Width	Cell Height	
C:\Documents and Settings\cwg\My Documents	4,159	Long Integer	0.000833333	0.000833333	
C:\Documents and Settings\cwg\My Documents	1,958	Long Integer	0.000833333	0.000833333	
					- +
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					-
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 $\circ~$ Click OK to start merging. Name the result sj1.

# Output Options		\mathbf{X}
Output File Format:	GeoTIFF (*.tif)	~
Output Data Type:	Long Integer (4 bytes)	
Output Path:	C:\temporary\dems	
Output Name:	si1	
	Add output to MapWindow	
		Cancel Finish

Click *Finish* and remove the clipped layers from the view. In the same way merge srtm_17_9_clip.tif and srtm_16_9_clip.tif to make sj2.tif, and finally merge sj1.tif and sj2.tif to make sj_dem_clip_ll.tif. Reload the watershed layer

(SJ_Maps\sj_washd_ll.shp) to verify the extents. This sj_dem_clip_ll.tif is the final DEM product that, when projected to UTM (see below) will be used in MWSWAT.

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2.1.2 Re-project DEM to UTM

Objective: Re-project the clipped DEM files to UTM and re-clip for the area of interest.

Due to the fact that MWSWAT needs meter units and an equal area projection to perform slope and area calculations, the clipped DEM needs to be re-projected to UTM coordinates¹. In this example, there is an additional dataset for the San Juan River watershed already projected in UTM. (additional shape file: **sj washd utm**: Zone 14N).

Re-project DEM and re-clip for Area of Interest:

- Select Toolbox\Raster\Reproject Grids.
- Select the clipped DEM in lat/long (**temporary\dems\sj_dem_clip_ll.tif**), and when loaded click OK to re-project.
- Choose projection details: WORLD, WGS 84, UTM Northern Hemisphere, and Zone 14N and the current projection values if MapWindow couldn't determine them (Geographical, WGS 1984).

¹ UTM is not an equal area projection, but is close to being so, and sufficiently close for SWAT to use on most watersheds



- A new file will be created (SJ_Maps\sj_dem_clip_ll_Reprojected.tif). Do *not* add this layer when asked, as its projection is different from the current one. Clear all layers and then add the layer SJ_Maps\sj_dem_clip_ll_Reprojected.tif. As a check, also add the watershed in UTM (SJ_Maps\sj_washd_utm.shp).
- Create a new clipping box in this UTM view (this will clean up the grid when reprojected).

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0 1062500 2125000 3187500 4250000
Meters
🔟 UTM Zone 14, Northern Hemisphere 🔻 Lat: 2,316,735.656 Long: 498,405.996 11:240572532774

Clip the re-projected dem with the UTM clip box. Select *Toolbox\Raster\Clip Grid With Polygon* and rename the output file as **sj_dem_clip_utm.tif**. OK to clip. When done, exit from MapWindow (do not save project changes) and copy the file **sj_dem_clip_utm.tif** to the project folder as this is going to be the DEM to be used with MWSWAT.

2.2 Landuse Data

2.2.1 Pre-Process of Landuse Data

Objective: Clip the Landuse file for the area of interest.

Clip Landuse for Area of Interest:

• Open the project **World_Data_Grids.mwprj** again. This shows that the tile we need for our area of interest is **na_land_3**.

🔜 MapWindow GIS - Worl	ld_Data_Grids*	
Project Layer View Bo	ookmarks Plug-ins Shapefile Editor Help	
New Open Save Print Sel	ettings	
Pan In Out Extent Sele	Deselect Measure Identify Label Mover Add Remove Clear	
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💹 WGS 84 💌 Lat: 92.529 Long	g: -135.176 1:269205858	

- Extract na_land_3.tif together with the corresponding .bmp, .bpw and .mwleg files from na_landuse_newres.zip (from the WaterBase web site http://www.waterbase.org/download_data.html). Store them in, say, temporary\land.
- Exit from MapWindow. Do NOT save the project data.
- Open mapWindow again, add layer: temporary\land\na_land_3.tif.
- *Hint: you can choose instead of* **na_landuse_newres.zip** *to use the tile from* **na_landuse.zip,** *the original landuse files. These tiles are large are large and take some time to display, and are also slow to react to any changes in the display. So as soon as*

such a tile is loaded, remove the tick from its legend, i.e. change to Ima_land_3 If This removes the display of the map. You can still proceed with the following steps of loading a clip box and clipping, but you can't see so clearly what is happening.

- Add the layer for the clip box (**SJ_Maps\sj_clip_box_ll.shp**).
- Select *Toolbox**Raster**Clip Grid With Polygon*. Select the landuse layer and the box to clip with from the ones just loaded into the view.

 Check the Clip to Extents (Fast) option and select the shape (clip box), press Done when the box is highlighted. Note that the output file name is created for you. Rename this to: temporary\land\sj_land_clip_ll.tif. Click OK to clip.



- Remove the layer **na_land_3**.
- Zoom to the layer of sj_clip_box_ll, and use add layer to reload the watershed layer (SJ_Maps\sj_washd_ll.shp) to verify the extents. This sj_land_clip_ll.tif is the final landuse product that, when projected to UTM (see below) will be used in MWSWAT.

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2.2.2 Re-project Landuse to UTM

Objective: Re-project the clipped landuse file to UTM and re-clip for the area of interest.

Due to the fact that MWSWAT needs meter units and an equal area projection to perform area calculations, the clipped landuse file needs to be re-projected to UTM coordinates². In this example, there is an additional dataset for the San Juan River watershed already projected to UTM. (additional shape file: **sj_washd_utm**: Zone 14N).

Re-project Land and re-clip for Area of Interest:

- Clear all the layers and select *Toolbox**Raster**Reproject Grids*.
- Open the clipped landuse file in lat/long (temporary\land\ sj_land_clip_ll.tif), when loaded click OK to re-project.

 $^{^2}$ UTM is not an equal area projection, but is close to being so, and sufficiently close for SWAT to use on most watersheds

- Choose projection details: WORLD, WGS 84, UTM Northern Hemisphere, and Zone 14N and the current projection values if MapWindow couldn't determine them (Geographical, WGS 1984).
- A new file will be created (temporary\land\sj_land_clip_ll_Reprojected.tif). Do not add the layer when asked, as it has a different projection, but clear all layers and then add it. Also add the watershed in UTM (SJ_Maps\sj_washd_utm.shp).
- Load the clipping box in UTM view (**SJ_Maps\sj_clip_box_utm.shp**) to re-clip and remove all the missing values generated with the rotation of the grid when re-projected.
- Clip the re-projected landuse with the UTM clip box. Select *Toolbox\Raster\Clip Grid With Polygon* and rename the output file as sj_land_clip_utm.tif. OK to clip. When done, exit from MapWindow (do not save project changes) and copy the file sj_land_clip_utm.tif to the project folder as this is going to be the landuse file to be used with MWSWAT.

2.3 Soil Data

2.3.1 Pre-Process of Soil Data

Objective: Clip the Soil file for the area of interest.

Clip Soil for Area of Interest:

• Open the project **World_Data_Grids.mwprj** again. This shows that the soil tile we need is **na_soil_3**.

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- Extract na_soil_3.tif together with the corresponding .bmp, .bpw and .mwleg files from na_soil.zip (from the WaterBase web site http://www.waterbase.org/download_data.html). Store them in, say, temporary\soil.
- Exit from MapWindow. Do NOT save project data.
- Add layer temporary\soil\na_soil_3.tif. Also add the layer for the clip box (SJ_Maps\sj_clip_box_ll.shp).
- Select *Toolbox\Raster\Clip Grid With Polygon*. Select the soil layer and the box to clip with from the ones just loaded into the view.
- Check the Clip to Extents (Fast) option and select the shape (clip box), press Done when the box is highlighted. Note that the output file name is created for you. Rename this default name to **temporary**soilsj_soil_clip_ll.tif. Click OK to clip.

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File Edit View Plug-ins MWSWAT GIS Tools Shapefile Editor	Watershed Delineation Help
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1 shape selected. Click OK to clip.	

Remove the layer na_soil_3. Use add layer to reload the watershed layer
 (SJ_Maps\sj_washd_ll.shp) to verify the extents. This sj_soil_ll_clip.tif is the final soil product that, when projected to UTM (see below) will be used in MWSWAT.

💀 MapWindow GIS *			
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2.3.2 Re-project Soil to UTM

Objective: Re-project the clipped soil file to UTM and re-clip for the area of interest.

Due to the fact that MWSWAT needs meter units and an equal area projection to perform area calculations, the clipped soil file need to be re-projected to UTM coordinates. In this example, there is an additional dataset for the San Juan River watershed already projected in UTM. (additional shapefile: **sj_washd_utm**: Zone 14N).

Re-Project Soil and re-clip for Area of Interest:

- Remove all the layers and select *Toolbox**Raster**Reproject Grids*.
- Open the clipped soil file in lat/long (**temporary**soil sj_soil_clip_ll.tif), when loaded click OK to re-project.
- Choose projection details: WORLD, WGS 84, UTM Northern Hemisphere, and Zone 14N and the current projection values if MapWindow couldn't determine them (Geographical, WGS 1984).
- A new file will be created (temporary\soil\sj_soil_clip_ll_Reprojected.tif). Do not add the layer when asked, as it has a different projection, but clear all layers and then add it. Also add the watershed in UTM (SJ_Maps\sj_washd_utm.shp).
- Load the clipping box in UTM view (**SJ_Maps\sj_clip_box_utm.shp**) to re-clip and remove all the missing values generated with the rotation of the grid when re-projected.
- Clip the re-projected soil with the UTM clip box. Select *Toolbox\Raster\Clip Grid With Polygon* and rename the output file as sj_soil_clip_utm.tif. OK to clip. When done, exit from MapWindow (do not save project changes) and copy the file sj_soil_clip_utm.tif to the project folder as this is going to be the soil file to be used with MWSWAT.

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3 Setup for Malawi: Linthipe Watershed3.1 Elevation Data (DEMs)

3.1.1 Pre-Process of DEM Data

Objective: Clip the SRTM file for the area of interest.

As an alternative to the derivative basins files, the users may have available their own map data for the region. In this example, there are additional datasets for: Malawi rivers, Lake Malawi and for the Linthipe watershed. (additional shapefiles: **malawi_rivers_ll, lake_malawi_ll & lin_wshd_ll**; all in lat/long).

Clip DEM for Area of Interest:

 Unzip World_Data_Grids.zip (from the WaterBase web site <u>http://www.waterbase.org/download_data.html</u>) and use MapWindow to open the project file World_Data_Grids.mwprj.



- Add the following layers: Global_Basins_latlong\af_bas_ll_r500m.shp (lat/long basins), Lin_Maps\lin_wshd_ll.shp and Lin_Maps\lake_malawi_ll.shp (user watershed file and Lake Malawi, just for reference purpose).
- Zoom in to the required level and create a shape file with a rectangle around the area of interest (namely the shape file Lin_Maps\lin_clip_box_ll.shp).



• For this watershed only one dem tile is required (**S_43_15**), easily identified Identify, so the only process left to do is clipping for the area of interest.

A

- Exit from MapWindow: do NOT save the changes to the project.
- Unzip srtm_43_15.zip to extract srtm_43_15.tif, storing it in temporary\dems and add it is a layer (being patient – it takes a few minutes). Also add the shapefile Lin_Maps\lin_clip_box_ll.shp.

Select *Toolbox*/*Raster*/*Clip Grid With Polygon*. Select the dem grid to clip and the shapefile to clip with..

 Check the Clip to Extents (Fast) option and select the shape (clip box), press Done when the box is highlighted. Note that the output file name is created for you (rename this file: temporary\dems\lin_dem_clip_ll.tif). Click OK to clip. • This **lin_dem_clip_ll.tif** is the final DEM product that, when projected to UTM (see the projection section) will be used in MWSWAT. When the clipping is done, remove the large DEM layer (**srtm_43_15.tif**).



• Reload the watershed (Lin_Maps\lin_wshd_ll.shp) to verify the extents.

3.1.2 Re-project DEM to UTM

Objective: Re-project the clipped DEM files to UTM and re-clip for the area of interest.

Due to the fact that MWSWAT needs meter units and an equal area projection to perform slope and area calculations, the clipped DEM needs to be re-projected to UTM coordinates³. In this example, there is an additional dataset for the Linthipe watershed already projected in UTM. (additional shapefile: **lin_wshd_utm**: Zone 36S).

Re-Project DEM and re-clip for Area of Interest:

- Select *Toolbox**Raster**Reproject Grids*.
- Open the clipped DEM in lat/long (temporary\dems\lin_dem_clip_ll.tif), when loaded click OK to re-project.
- Choose projection details: WORLD, WGS 84, UTM Southern Hemisphere, and Zone 36S and the current projection values if MapWindow couldn't determine them (Geographical, WGS 1984).

³ UTM is not an equal area projection, but is close to being so, and sufficiently close for SWAT to use on most watersheds

- A new file will be created (temporary\dems\lin_dem_clip_ll_Reprojected.tif). Do not add this layer when asked, as it has a different projection. Clear all layers, then add the reprojected DEM and the watershed in UTM (Lin_Maps\Geo_processed\lin_wshd_utm.shp).
- Create a new clipping box in this UTM view (this will remove all the missing values generated with the rotation of the grid when re-projected).

🗇 MapWindow GIS *
Project Layer View Bookmarks Plug-ins Shapefile Editor Help
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0 237500 475000 712500 950000
Meters
🔟 UTM Zone 36, Southern Hemisphere 🔻 Lat: 8,515,557.224 Long: 608,725.248 1:275127832193

 Clip the re-projected DEM with the UTM clip box. Select *Toolbox\Raster\Clip Grid With Polygon* and rename the output file as lin_dem_clip_utm.tif. OK to clip. When done, exit from MapWindow (do not save project changes) and copy this final file to the project folder as this is going to be the DEM to be used with MWSWAT.

3.2 Landuse Data

3.2.1 Pre-Process of Landuse Data

Objective: Merge and clip the Landuse files for the area of interest.

Clip Landuse for Area of Interest:

• Exit from MapWindow, and open the project **World_Data_Grids.mwprj** again. This shows that the tile we need for our area of interest is **af_land_2**.

MapWindow GIS - World_Data_Grids*		
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💹 WGS 84 🔻 🛛 Lat: 66.841 Long: -182.212	1:336	6308644

- Extract **af_land_2.tif** together with the corresponding .bmp, .bpw, and .mwleg files from **af_landuse_newres.zip** (from the WaterBase web site <u>http://www.waterbase.org/download_data.html</u>). Store them in, say, **temporary\land**.
- Exit from MapWindow. Do NOT save the project data.
- Add layer **temporaryland af_land_2.tif** (note: be patient! MapWindow takes a few minutes to load the file).
- Hint: you can choose instead of af_landuse_newres.zip to use the tile from af_landuse.zip, the original landuse files. These tiles are large are large and take some time to display, and are also slow to react to any changes in the display. So as soon as such a tile is loaded, remove the tick from its legend, i.e. change
 af_land_2 # to for af_land_2 # This removes the display of the map. You can still proceed with the following steps of loading a clip box and clipping, but you can't see so clearly what is happening.
- Add the layer for the clip box (Lin_Maps\lin_clip_box_ll.shp).
- Select *Toolbox**Raster**Clip Grid With Polygon*. Select the landuse layer and the box to clip with from the ones just loaded into the view.

• Check the Clip to Extents (Fast) option and select the shape (clip box), press Done when the box is highlighted. Note that the output file name is created for you. Rename this default name: temporary\land\lin_land_ll_clip.tif. Click OK to clip.



- Remove the layer **af_land_2**.
- Zoom to the layer of lin_clip_box_ll and with add layer reload the watershed layer (Lin_Maps\lin_wshd_ll.shp) to verify the extents. This lin_land_ll_clip.tif is the final landuse product that, when projected to UTM (see below) will be used in MWSWAT.



3.2.2 Re-project Landuse to UTM

Objective: Re-project the clipped landuse file to UTM and re-clip for the area of interest.

Due to the fact that MWSWAT needs meter units and an equal area projection to perform area calculations, the clipped landuse file need to be re-projected to UTM coordinates⁴. In this example, there is an additional dataset for the Linthipe watershed already projected to UTM. (additional shape file: **lin_wshd_utm**: Zone 36S).

Re-Project Landuse and re-clip for Area of Interest:

- Clear all the layers and select *Toolbox**Raster**Reproject Grids*.
- Open the clipped landuse file in lat/long (temporary\land\ lin_land_clip_ll.tif), when loaded click OK to re-project.

⁴ UTM is not an equal area projection, but is close to being so, and sufficiently close for SWAT to use on most watersheds

- Choose projection details: WORLD, WGS 84, UTM Southern Hemisphere, and Zone 36S and the current projection values if MapWindow couldn't determine them (Geographical, WGS 1984).
- A new file will be created (temporary\land\Lin_land_clip_ll_Reprojected.tif). Do not add the layer when asked, as it has a different projection, but clear all layers and then add it. Also add the watershed in UTM (Lin_Maps\Geo_processed\lin_wshd_utm.shp).
- Load the clipping box in UTM view (Lin_Maps\sj_clip_box_utm.shp) to re-clip and remove all the missing values generated with the rotation of the grid when re-projected.

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💹 UTM Zone 36, Southern Hemisphere 🝷 Lat: 8,459,	067.905 Long: 509	,325.316			1:3059701	33466		

Clip the re-projected landuse with the UTM clip box. Select *Toolbox\Raster\Clip Grid With Polygon* and rename the output file as lin_land_clip_utm.tif. OK to clip. When done, exit from MapWindow (do not save project changes) and copy the file lin_land_clip_utm.tif to the project folder as this is going to be the landuse file to be used with MWSWAT.

3.3 Soil Data

3.3.1 Pre-Process of Soil Data

Objective: Clip the soil file for the area of interest.

Clip Soil for Area of Interest:

• Open the project **World_Data_Grids.mwprj** again. This shows that the soil tile we need is **af_soil_2**.

💀 MapWindow GIS - World_Data_Grids*	
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🔀 WGS 84 🔻 🛛 Lat: 94.121 Long: -77.905	1:336308644

- Extract af_soil_2.tif together with the corresponding .bmp, .bpw and .mwleg files from af_soil.zip (from the WaterBase web site http://www.waterbase.org/download_data.html). Store them in, say, temporary\soil.
- Exit from MapWindow. Do NOT save project data.
- Add layer **temporary**soil **af_soil_2.tif.** Also add the layer for the clip box (Lin_Maps\lin_clip_box_ll.shp).
- Select *Toolbox\Raster\Clip Grid With Polygon*. Select the soil layer and the box to clip with from the ones just loaded into the view.
- Check the Clip to Extents (Fast) option and select the shape (clip box), press Done when the box is highlighted. Note that the output file name is created for you. Rename this default name: temporary/soil/lin_soil_clip_ll.tif. Click OK to clip.

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1 shape selected. Click OK to clip.		Opened Grid, Status True

- Remove the layer **af_soil_2**.
- Zoom out and with add layer reload the watershed layer (Lin_Maps\lin_wshd_ll.shp) to verify the extents. This lin_land_ll_clip.tif is the final landuse product that, when projected to UTM (see below) will be used in MWSWAT.

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3.3.2 Re-project Soil to UTM

Objective: Re-project the clipped soil file to UTM and re-clip for the area of interest.

Due to the fact that MWSWAT needs meter units and an equal area projection to perform area calculations, the clipped soil file need to be re-projected to UTM coordinates⁵. In this example, there is an additional dataset for the Linthipe watershed already projected in UTM. (additional shapefile: **lin_wshd_utm**: Zone 36S).

Re-Project Soil and re-clip for Area of Interest:

- Remove all the layers and select *Toolbox**Raster**Reproject Grids*.
- Open the clipped soil file in lat/long (temporary\soil\ lin_soil_clip_ll.tif), when loaded click OK to re-project.
- Choose projection details: WORLD, WGS 84, UTM Southern Hemisphere, and Zone 36S and the current projection values if MapWindow couldn't determine them (Geographical, WGS 1984).
- A new file will be created (**temporary**soil\lin_soil_clip_ll_Reprojected.tif). Do not add the layer when asked, as it has a different projection, but clear all layers and then add it. Also add the watershed in UTM (Lin_Maps\Geo_processed\lin_wshd_utm.shp).
- Load the clipping box in UTM view (Lin_Maps\sj_clip_box_utm.shp) to re-clip and remove all the missing values generated with the rotation of the grid when re-projected.

⁵ UTM is not an equal area projection, but is close to being so, and sufficiently close for SWAT to use on most watersheds

^(a) MapWindow GIS *	
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C:\temporary\soil\lin_soil_clip_utm.tif	
Add Results to Map OK Cancel	
1 shape selected. Click OK to clip.	ed Grid, Status True

Clip the re-projected soil with the UTM clip box. Select *Toolbox\Raster\Clip Grid With Polygon* and rename the output file as lin_soil_clip_utm.tif. OK to clip. When done, exit from MapWindow (do not save project changes) and copy the file (lin_soil_clip_utm.tif) in the project folder as this is going to be the soil file to be used with MWSWAT.