

Interactive SwaNET Model Creation 1: Watershed Delineation- Create Stream Network

This tutorial explains how to create a SwaNET project and delineate a watershed. As the watershed delineation starts with a DEM (digital elevation model) map, multiple ways of loading DEMs are discussed.

This tutorial assumes that the user has created a MAGNET4WATER account, which is required to submit jobs for loading SwaNET projects, running simulation, saving models, etc.

- a. Click on 'Create SWAT Model' at the top left side of the SwaNET model interface.

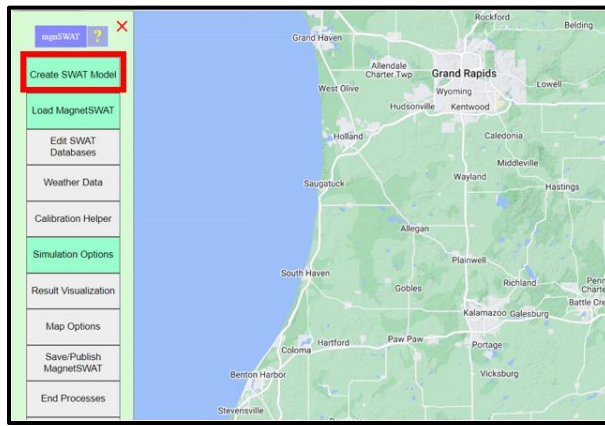


Figure 1. Loading interactive watershed delineation interface

A new interface appears that allows users to load DEM on to SwaNET project and start watershed delineation.

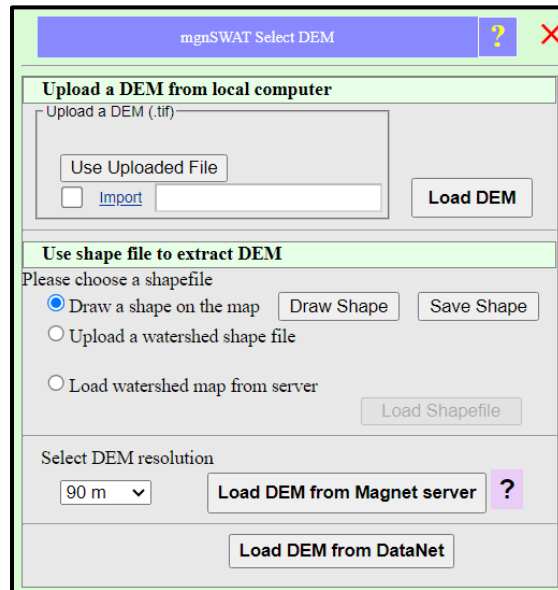


Figure 2. DEM loading interface

1 Load DEM from local computer

To upload a DEM from local computer:

- a. Check the box on the left of 'Import', and click 'Import'. Browse to the file location, select the file, and click 'Open'. The selected file is uploaded to the MAGNET server, and the file name is displayed.

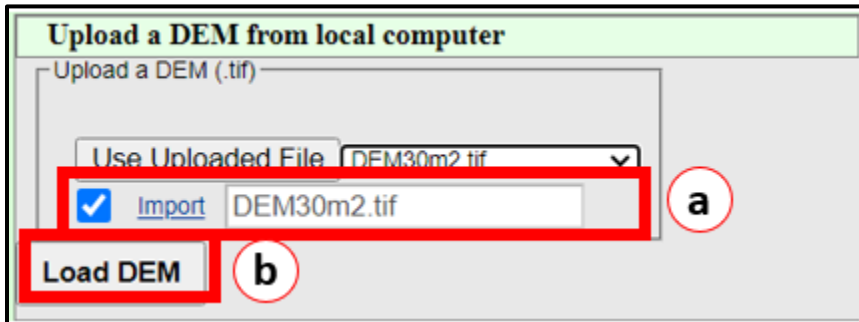


Figure 3. Loading a new DEM from local computer

- b. Click 'Load DEM'.

A new SwaNET project is created, the uploaded DEM is copied to SwaNET folder, and the DEM/hillshade map is plotted and displayed as shown in Figure 4. SwaNET requires DEM in a projected coordinate system. If the uploaded map is not in projected coordinate system (e.g. geographic coordinate system), the DEM is projected to the local Universal Transverse Mercator (UTM) zone. Currently, only tif and img raster maps are supported.



Figure 4. DEM and hillshade loaded

Load a previously uploaded DEM:

- a. Click 'Use Uploaded File' button
- b. Select a file from the list next to the button.

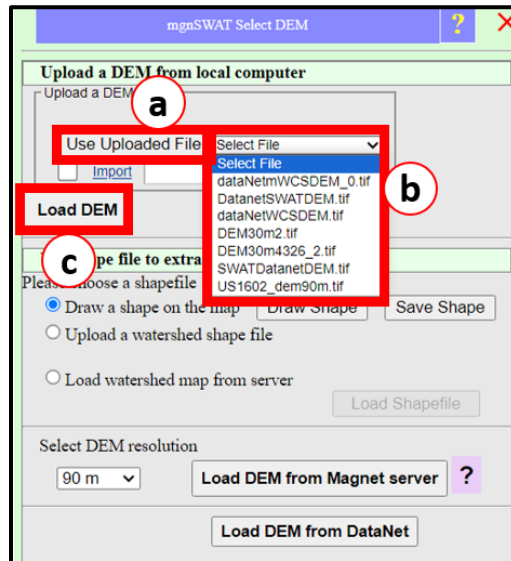


Figure 5. Loading previous uploaded DEM

- c. Click 'Load DEM'.

A new SwaNET project is created, the uploaded DEM is copied to SwaNET folder, and the DEM/hillshade map is plotted and displayed as shown in Figure 4.

2 Load DEM from MAGNET server

MAGNET- SwaNET has a built-in DEM database that allows users to load DEM with simple few clicks. To extract DEM from MAGNET server, users need to provide a boundary of the area of interest in the form of a shape file. The shape file can be drawn, uploaded, or loaded from MAGNET server.

2a. Draw a shape

- a. Select 'Draw a shape on the map' under 'Use shape file to extract DEM'.

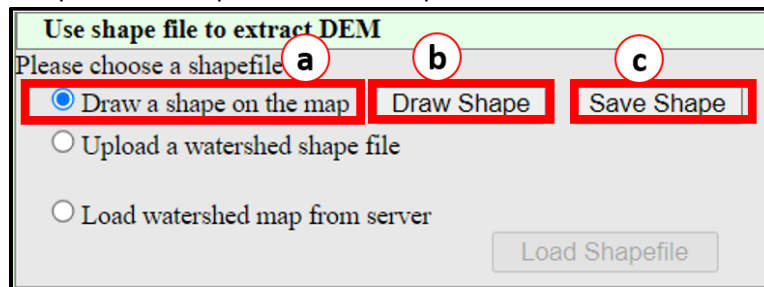


Figure 6. Drawing a shape as a model boundary

- b. Click 'Draw Shape' and draw the bounding box around the are of interest. Draw as many times as needed until the correct area of interest is captured.

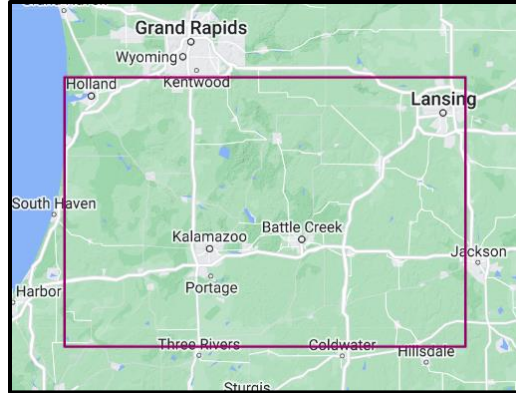


Figure 7. Shape drawn on the map

- c. Click 'Save Shape'.

The shape is uploaded, saved in the user SwaNET folder, and plotted.

2b. Upload a watershed shape file from local computer

Users can upload their own shape file for DEM extraction. The shape file can either be a zip (.zip) file containing at least .shp, .prj, and .dbf files, or GeoJSON file .

Upload a new shape file:

- a. Select 'Upload a watershed shape file' under 'Use shape file to extract DEM'.

Figure 8. Uploading a new shape file

- b. Check the box on the left of 'Import', and click 'Import'.
- c. Browse to the file location, select the file, and click 'Open'. The selected file is uploaded to the MAGNET server, and the file name is displayed.
- d. Click 'Load Shapefile'.

The shape is uploaded, saved in the user SwaNET folder, and plotted as shown in Figure 9. Note that the uploaded shape file might be different from the one shown in Figure 9.



Figure 9. User shape file plotted in background map

To load a previously uploaded shape file:

- a. Select 'Upload a watershed shape file' under 'Use shape file to extract DEM'.

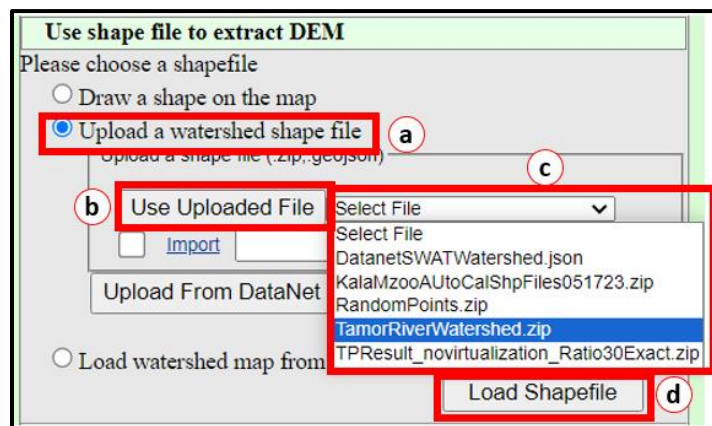


Figure 10. Loading a previously uploaded shape file

- b. Click 'Use Uploaded File'.
- c. Click 'Select File' and select a shapefile from the list.
- d. Click 'Load Shapefile'.

The shape is loaded, saved in the user MAGNET4WATER folder, and plotted as shown in Figure 9. Note that the uploaded shape file might be different from the one shown in Figure 9.

2c. Upload a watershed shape file from DataNet

Shapefile can also be loaded from DataNet, a MAGNET platform for visualizing and downloading raster/vector data from GeoServers.

To upload shape file from DataNet:

- a. Select 'Upload a watershed shape file' under 'Use shape file to extract DEM'.

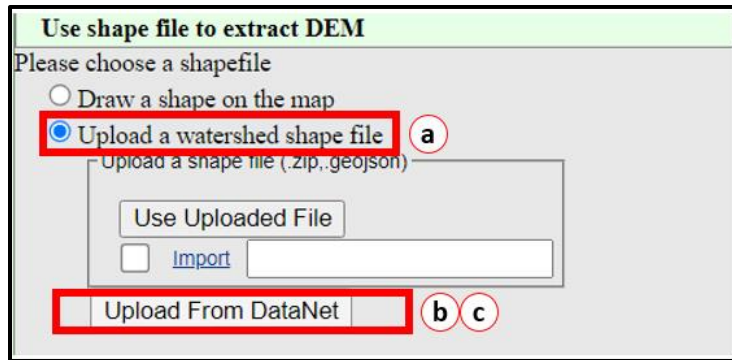


Figure 11. Loading a shape file from DataNet

- b. Click 'Upload From DataNet'. If clicking for the first time, a prompt appears warning that no DataNet page found. Click 'OK'. DataNet page opens in a new tab with login prompt. Close the login prompt, go to the MAGNET SwaNET page.

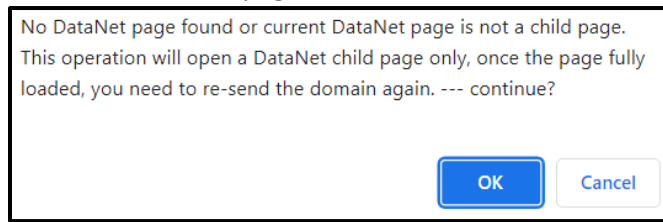


Figure 12. DataNet page not found warning

- c. Click 'Upload from DataNet' one more time and go to DataNet page.

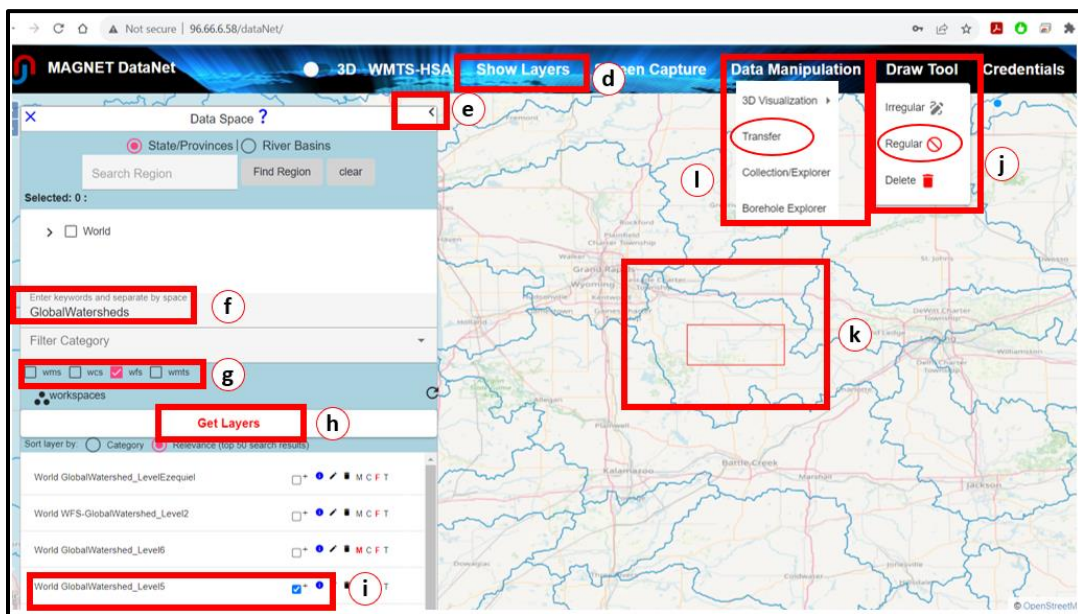


Figure 13. Selecting watershed shape file in DataNet

- d. Click 'Show Layers' from the top menu. Layer selection interface appears on the left.
- e. Click on the '>' sign next to 'Data Space ?' to expand the search interface.

Let's load a watershed in Michigan as an example.

- f. Under 'Enter keywords....', type 'GlobalWatersheds'.
- g. Under 'Filter Category', uncheck all except 'WFS'.
- h. Click 'Get Layers'. A list of map layers matching the search criteria are listed.
- i. From the list below, check the checkbox next to 'World GlobalWatershed_Level5'. Watershed maps are displayed. Click and drag the map to the United States and use mouse scroll button to zoom to Michigan.
- j. Click 'Draw Tool' from the top menu, and click 'Regular' from the drop down menu.
- k. Draw a small rectangle inside a watershed.
- l. Click 'Data Manipulation' from the top menu and click 'Transfer'. A new interface appears.

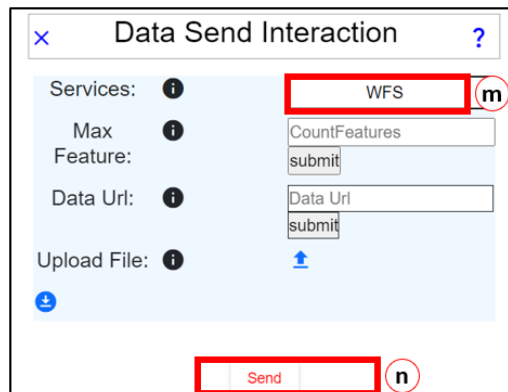


Figure 14. Data transfer interface in DataNet

- m. Select 'WFS' from the dropdown list next to 'Services'
- n. Click 'Send'. A message showing 'Data Transferred' appears. Click 'OK'.
- o. Go to the MAGNET SwaNET interface. A message appears asking whether to receive data. Click 'OK'.

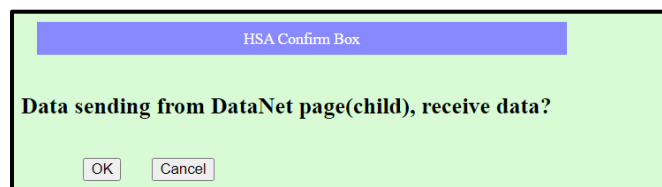


Figure 15. Data receive notification

- p. Another warning appears asking whether to overwrite existing DataNet imported shape file. Click 'OK'. The shapefile is uploaded to the server and the file name is displayed.

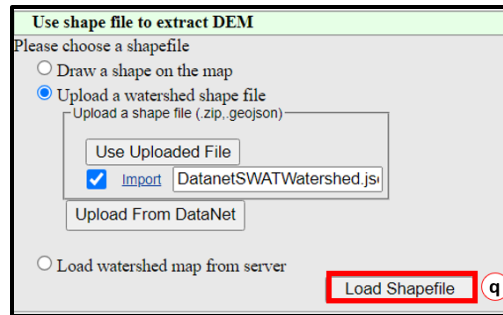


Figure 16. Loading shape file from MAGNET server

- q. Click 'Load Shapefile'.

The shape is loaded, saved in the user SwaNET folder, and plotted as shown in Figure 9. Note that the uploaded shape file might be different from the one shown in Figure 9.

2d. Load watershed shape file from MAGNET server

- a. Select 'Load watershed map from server' under 'Use shape file to extract DEM'. Pan/zoom background map to find the point of interest.

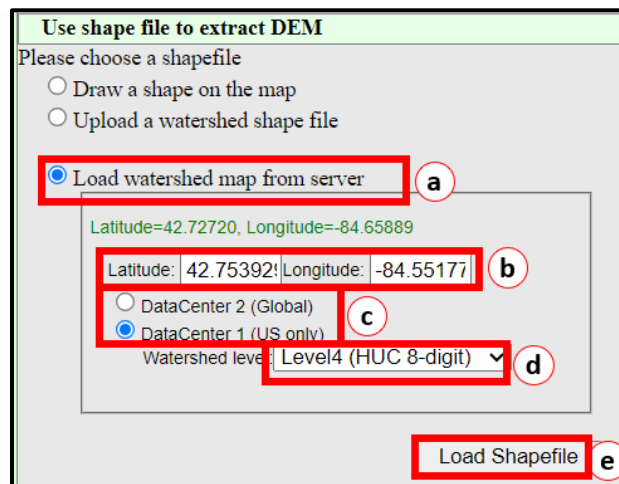


Figure 17. Loading watershed shape file from MAGNET server

- b. Click on the point on the map. Latitude/longitude of the location are displayed.
- c. Select the type of watershed map needed. Select either 'DataCenter 2 (Global)' for loading Hydrosheds (<https://www.hydrosheds.org/>) watersheds around the world or 'DataCenter 1 (US only)' for loading HUC watersheds in the US.
- d. Select the watershed level to load watershed shape file. Level 1 (HUC 2-digit) are largest watershed map available while Level 6 (HUC 12-digit) are smallest watershed map available.
- e. Click 'Load Shapefile'. The shape is loaded, saved in the user SwaNET folder, and plotted as shown in Figure 9. Note that the loaded shape file might be different from the one shown in Figure 9.

2e. Load DEM

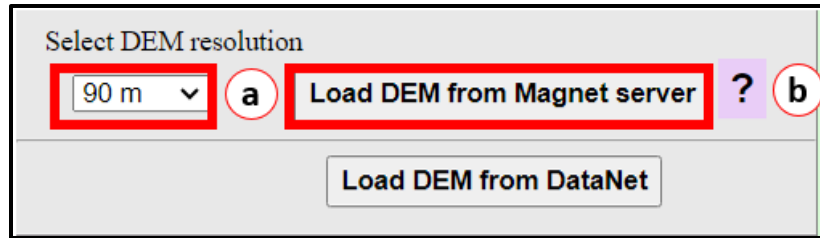


Figure 18. Loading DEM from MAGNET server

- a. Once the watershed shape file is loaded, select the DEM resolution from the dropdown list. Most suitable DEM resolution is selected by default. Please note that higher resolution DEM is not currently available outside the US. In the US, up to 10m DEM is available.
- b. Click 'Load DEM from MAGNET server'. The DEM tiles are extracted, merged, cropped to extent, and plotted as shown in Figure 4. Note that the extracted DEM might be different from the one shown in Figure 4.

3 Load DEM from DataNet

DEM can also be loaded from DataNet, a MAGNET platform for visualizing and downloading raster/vector data from GeoServers. DEM can be uploaded from DataNet with or without watershed boundary.

3a. Load DEM without a bounding box

To load DEM from DataNet without existing watershed boundary:

- a. Click 'Load DEM from DataNet'. If clicking for the first time, a prompt appears warning that no DataNet page found. Click 'OK'. DataNet page opens in a new tab with login prompt. Close the login prompt, go to the MAGNET SwaNET page and click 'Load DEM from DataNet' one more time. A prompt appears warning that no domain polygon found. Click 'OK'.

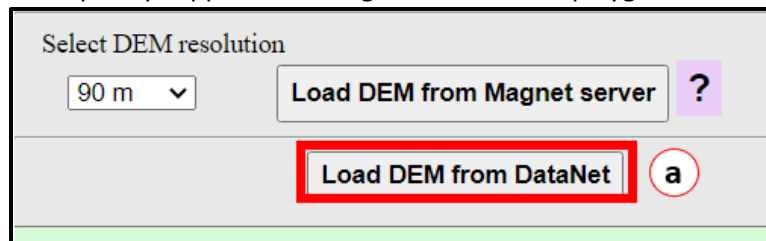


Figure 19. Selecting DEM from DataNet

- b. Go to the DataNet interface. Click 'Show Layers' from the top menu.
- c. Click on the '>' sign next to 'Data Space ?' to expand the search interface.

Lets load DEM in selected area Michigan as an example. Click and drag the map to the United States and use mouse scroll button to zoom to Michigan.

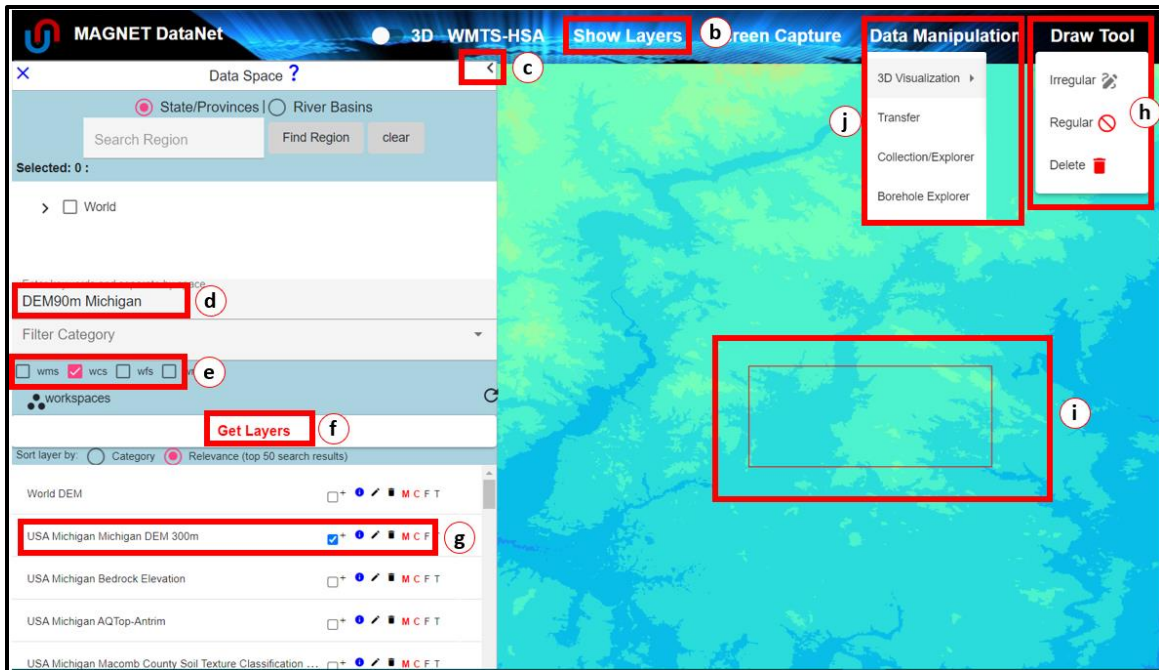


Figure 20. Loading DEM from DataNet

- d. Under 'Enter keywords....', type 'DEM90m Michigan'.
- e. Under 'Filter Category', uncheck all except 'WCS'.
- f. Click 'Get Layers'. Available raster maps are listed.
- g. From the list below, check the checkbox next to 'USA Michigan Michigan DEM 300m'.
- h. Click 'Draw Tool' from the top menu, and click 'Regular' from the drop down menu.
- i. Draw a rectangle around the area of interest.
- j. Click 'Data Manipulation' from the top menu and click 'Transfer'. Data transfer interface appears.

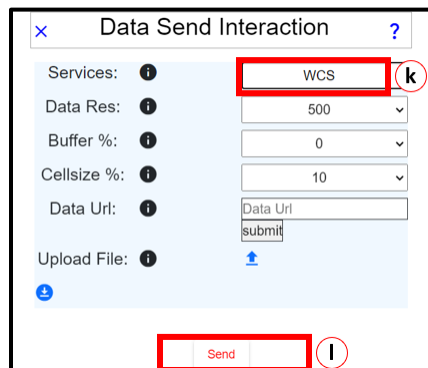


Figure 21. Data transfer interface on DataNet

- k. Select 'WCS' from the dropdown list next to 'Services'.
- l. Click 'Send'. A message showing 'Data Transferred' appears. Click 'OK'.
- m. Go to the SwaNET interface. A message appears asking whether to receive data. Click 'OK'.

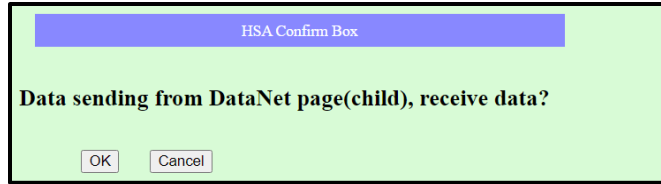


Figure 22. Data receive notification

- n. Another warning appears asking whether to overwrite existing DataNet imported DEM. Click 'OK'. The shapefile is uploaded to the server and the file name is displayed. Click OK.

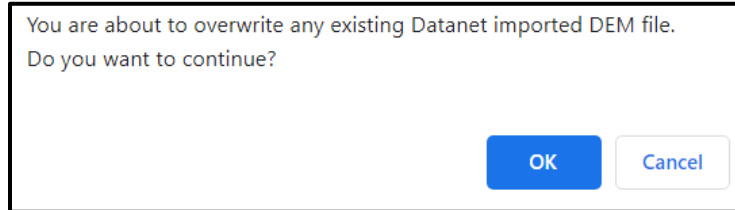


Figure 23. Data overwrite notification

DEM is uploaded to the server, placed in SwaNET project and plotted as shown in Figure 4. Note that the uploaded DEM might be different from the one shown in Figure 4.

3b. Load DEM with a bounding box

To load DEM from DataNet with existing watershed boundary, load a shape file following instructions above.

Follow the instructions above except that there is no 'no domain polygon found' warning and users do not need to draw a rectangle.

4 Create stream network

Once the DEM file has been loaded, stream network creation interface appears. It can also be opened by clicking 'Threshold selection' tab on the left. This interface allows users to burn-in stream network, select threshold and create stream network. DEM properties can also be viewed in this interface.

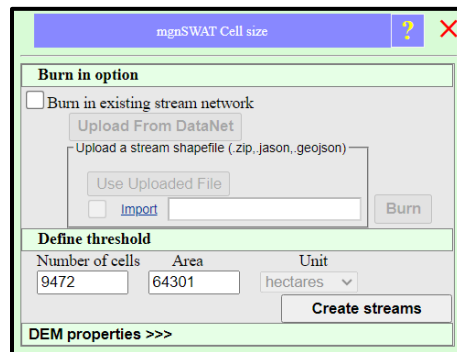


Figure 24. Stream network creation interface

4a. Burn-in stream network (optional)

Burn-in stream network allows users to superimpose stream network onto the DEM so that the resulting stream network matches the user stream network shape file. The shape file can either be a zip (.zip) file containing at least .shp, .prj, and .dbf files, or GeoJSON file .

Upload a new stream network shape file:

- a. check 'Burn in existing stream network' checkbox.

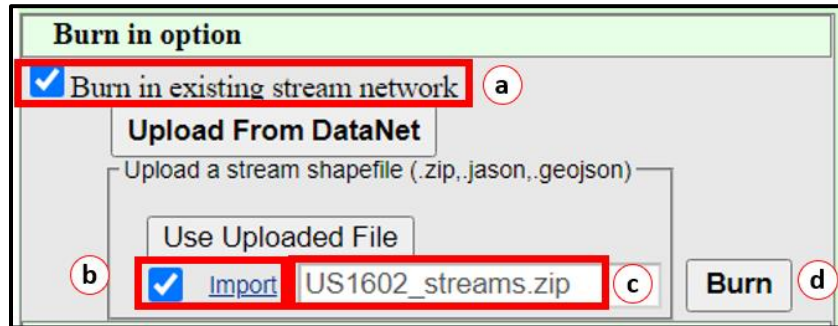


Figure 25. Uploading user shape file as burn-in stream network

- b. Check the box on the left of 'Import', and click 'Import'.
- c. Browse to the file location, select the file, and click 'Open'. The selected file is uploaded to the MAGNET server, and the file name is displayed.
- d. Click 'Burn'. The stream file in burn-in to the existing DEM, and the DEM map is updated.

To load a previously uploaded shape file:

- a. check 'Burn in existing stream network' checkbox.
- b. Click 'Use Uploaded File' button. Previously loaded shape files are listed.
- c. Click 'Select File' and select a file from the list next to the button.

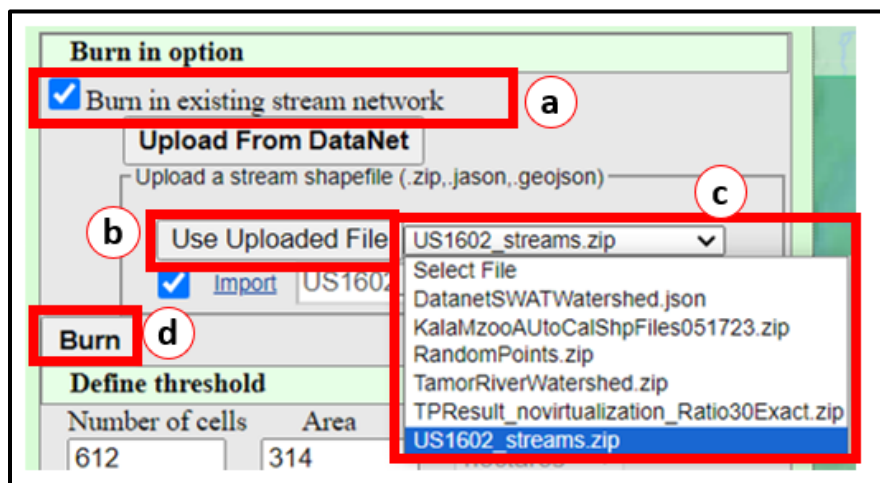


Figure 26. Loading previously loaded burn-in stream network

- d. Click 'Burn'. The stream file in burn-in to the existing DEM, and the DEM map is updated.

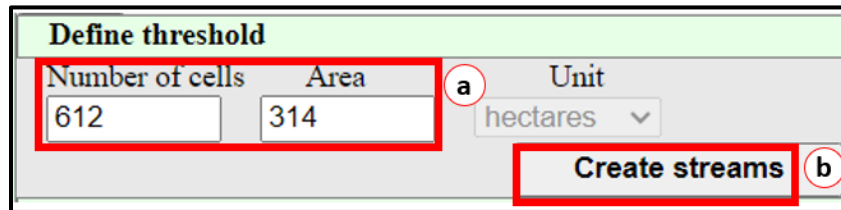
To upload a previously burn-in file from DataNet:

To upload a stream network file from DataNet, please follow the instructions on 2a above to select appropriate stream network file and load.

Once the stream network file is loaded, click 'Burn'. The DEM is modified based on the stream network, and the burned-in DEM map is displayed.

4b. Threshold selection and stream creation

The threshold area is the minimum drainage area required to form the origin of a stream. Thus, the threshold area determines the minimum subbasin area, and hence, the number of subbasins in the watershed. The larger the threshold area, the lesser the number of subbasins and vice versa.



Define threshold		
Number of cells	Area	Unit
612	314	hectares
Create streams		

Figure 27. Selecting threshold and creating stream network

- a. A default number of cells and areas are provided. To change, enter either the new number of cells or new area.
- b. Click 'Create streams'. Stream network is created, and displayed on the map. Repeat the process, if needed to get the desired number of subbasins.

Stream network is created and displayed on the background map.

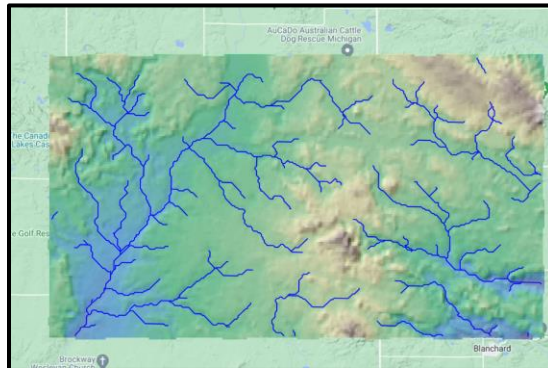


Figure 28. Stream network

5 View DEM properties

To view DEM properties, click 'DEM properties'. The interface expands and shows bounding box, cell size, map projection and full projection string.

DEM properties <<<

Cell size	Cell area (ha)
71.6 x 71.6	0.5122

DEM extent:

North	West	East	South
43°38'46"	-85°20'15"	-85°2'49"	43°31'11"

Spatial reference: WGS_1984_UTM_Zone_16N

Projection information:

```
PROJCS["WGS_1984_UTM_Zone_16N",GEOGCS["GCS_WG
S_1984",DATUM["D_WGS_1984",SPHEROID["WGS_1984
",6378137.0,298.257223563]],PRIMEM["Greenwich
",0.0],UNIT["Degree",0.0174532925199433]],PRO
JECTION["Transverse_Mercator"],PARAMETER["Fal
se_Easting",500000.0],PARAMETER["False_Northi
```

Figure 29. DEM properties