

Using HMS-PrePro

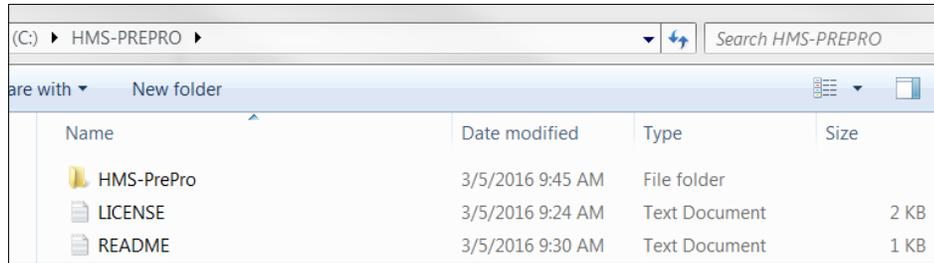
Prepared By: Cynthia V. Castro (March 2016)

HMS-PrePro contains ArcGIS geoprocessing script tools for extracting data from Esri's Living Atlas, deriving a watershed network, estimating hydrological parameters, and storing results in a .BASIN output ASCII file that may be used as input for the HEC-HMS watershed modeling software.

Download: <http://tools.cwr.utexas.edu/HMS-PrePro>

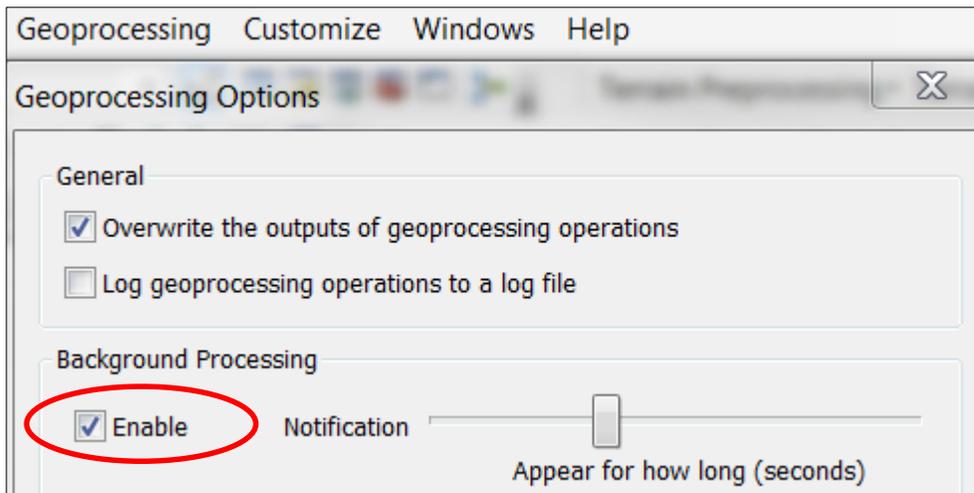
Installation / Set-Up

- 1) Copy or unzip the HMS-PREPRO folder to any location on your hard drive



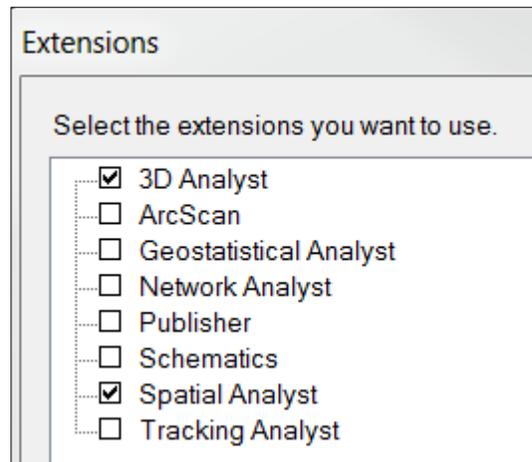
- 2) Ensure you have 64-bit geoprocessing capabilities by looking for a folder containing **ArcGISx64** in *C:\Python27*. If you do not see this folder, contact your system administrator for installation. Running HMS-PrePro without the 64-bit background geoprocessing may cause failures or a notably longer execution time.

Enable background geoprocessing (64-bit) by clicking the **Geoprocessing** tab from the ArcMap toolbar and selecting the **Enable** box under Background Processing. Click **OK**.



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- 3) Enable the 3D Analyst and Spatial Analyst extensions by selecting the **Customize** tab from the ArcMap toolbar and choosing **Extensions**. Select the box next to 3D Analyst and Spatial Analyst.



- 4) Ensure **ArcHydro** is installed. In ArcMap you will see this toolbar:



- a. If not, download and install the appropriate version of Arc Hydro tools here:
<http://downloads.esri.com/archydro/ArcHydro/Setup/>
 - b. If you have a 64-bit computer, use the "x64" version for faster background processing.
- 5) The use of Esri Living Atlas landscape layers requires an ArcGIS Online **organizational account**. This is different than an ArcGIS Online personal or global account. You may have been invited to become a member of an ArcGIS organizational account through your school or workplace. If so, it is recommended to use the login credentials registered with that organization when using HMS-PrePro. Contact your organization's administrator for access.

If you have not been invited to join an existing organizational account, you may create a temporary one by signing up for the developer trial here:

- c. <https://developers.arcgis.com/sign-up/>
- d. NOTE: Access to the landscape layers within the Living Atlas is free and does not consume any of your organizational credits/tokens.

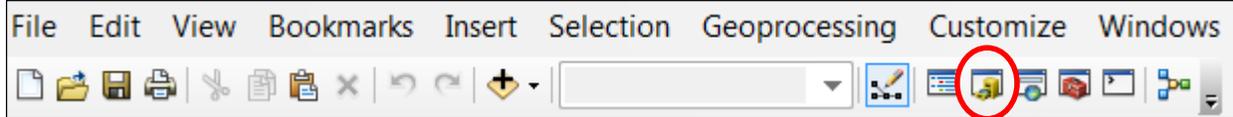
** Prior to running HMS-PrePro, ensure that you are logged into your organizational account in ArcMap by selecting File >> **Sign In...**

Using HMS-PrePro

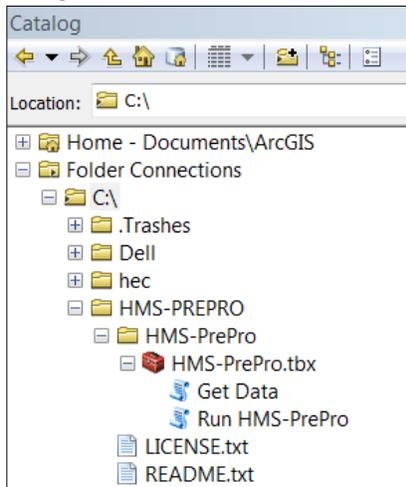
Open HMS-PrePro

Using ArcCatalog:

Open ArcCatalog within ArcMap



Navigate to the installation directory in ArcCatalog and expand the HMS-PrePro folder.



Double-click on the script tool to run.

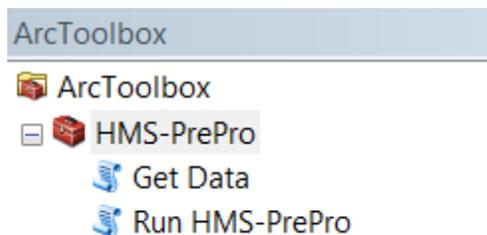
Or, using ArcToolbox:

Open ArcToolbox within ArcMap



Right-click the **ArcToolbox** folder and select **Add Toolbox**.

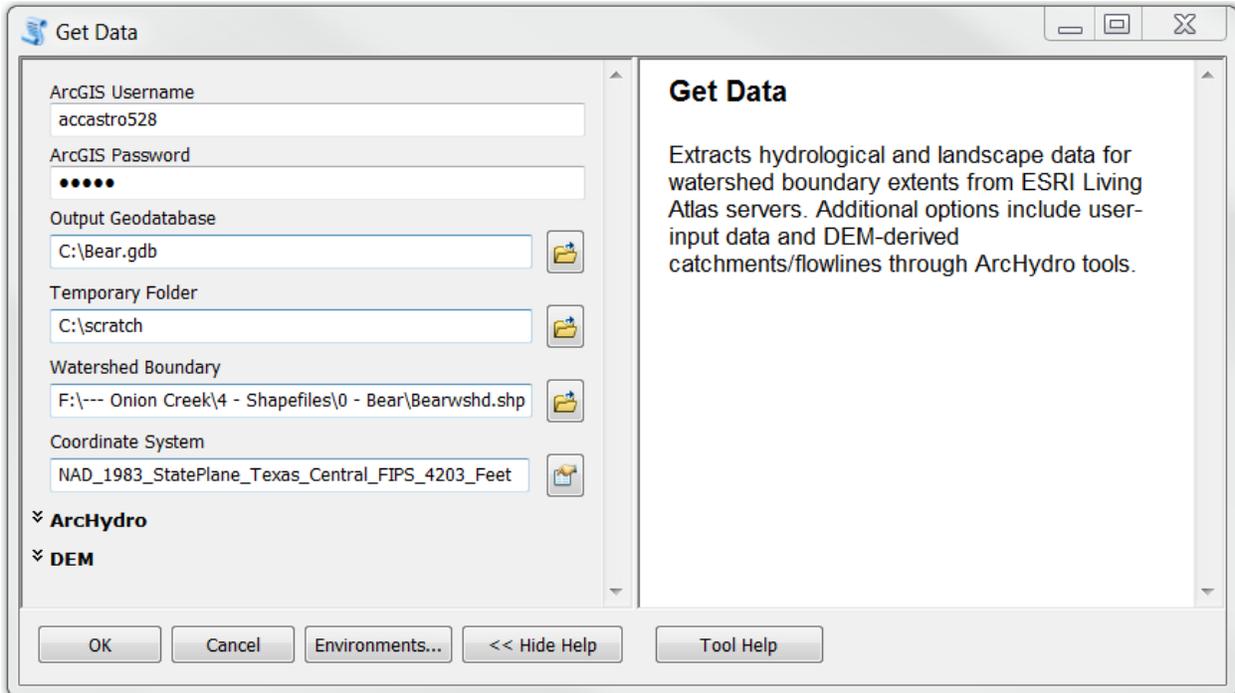
Navigate to the HMS-PREPRO directory and select the **HMS-PrePro.tbx**. Click **Open**.



Using HMS-PrePro

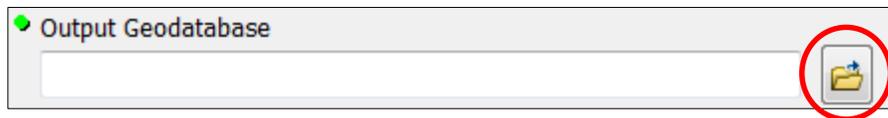
Using the HMS-PrePro *GetData* Tool

- 1) Double-click on the *GetData* script



NOTE: If you encounter an error, first try closing out of ArcMap and re-opening a blank project.

- 2) ArcGIS Username / ArcGIS Password
 - a. Input your ArcGIS organizational username and password.
- 3) Output Geodatabase
 - a. Create an empty geodatabase and navigate to that directory. This is where the output layers will be saved. (NOTE: It is possible to create an empty geodatabase within the tool by selecting the **New File Geodatabase** icon, as shown below.)



After selecting **New File Geodatabase**, rename the *New File Geodatabase.gdb* and select the  icon only once to add the .gdb to the Name field. Select **Add**.

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4) Temporary Folder

- a. Create an empty folder and navigate to that directory. This is where scratch files for the NHDPlusv2.1 data will be saved.



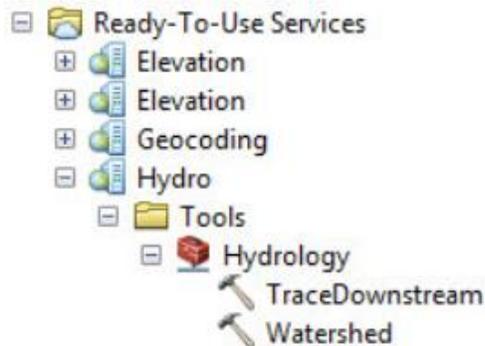
Data in the Scratch Folder may be deleted after running the *Get Data* script.

5) Watershed Boundary

- a. Navigate to the watershed boundary layer. This layer may be a shapefile (.shp) or a feature class within a geodatabase.
- b. If you do not have a watershed boundary layer, you may create one for an area of interest using the ArcGIS Watershed service tool (not part of this tutorial).

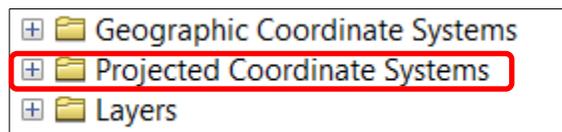
For more information about using the Watershed tool, visit:

<http://www.arcgis.com/home/item.html?id=8e48f6209d5c4be98ebbf90502f41077>



6) Output Coordinates

- a. Select the desired output coordinate system.
 - i. For hydrological purposes, ensure the output coordinate system preserves spatial area. Examples include the Albers Equal Area Conic projection or the State Plane systems.
 - ii. For use with the HMS-PrePro processing script, a Projected Coordinate System must be selected.
 - iii. NOTE: The projected coordinate system only applies to the Subbasin and Reach layers. The landscape rasters (soils, land use, impervious, and DEM) will remain in the North America Albers Equal Area Conic projection for spatial analysis.

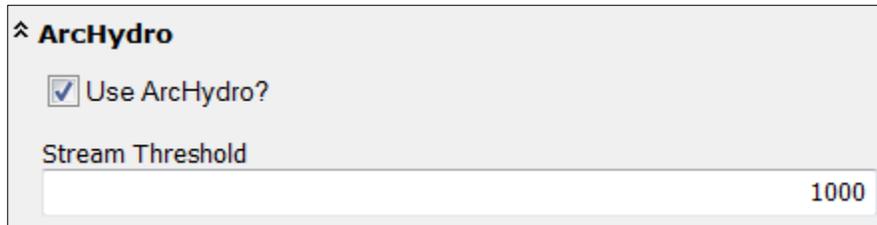


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ArcHydro

Select the **Use ArcHydro** option if you wish to derive the stream network (subbasins, reaches, nodes) from a DEM using ArcHydro tools instead of the NHDPlusV2.1 catchments and flowlines. HMS-PrePro will use the stream threshold to delineate the watershed from a DEM.

Provide a **Stream Threshold** based on the number of DEM cells that you wish to define the stream. The default value is 1000. Smaller stream thresholds will produce more drainage units.



^ **ArcHydro**

Use ArcHydro?

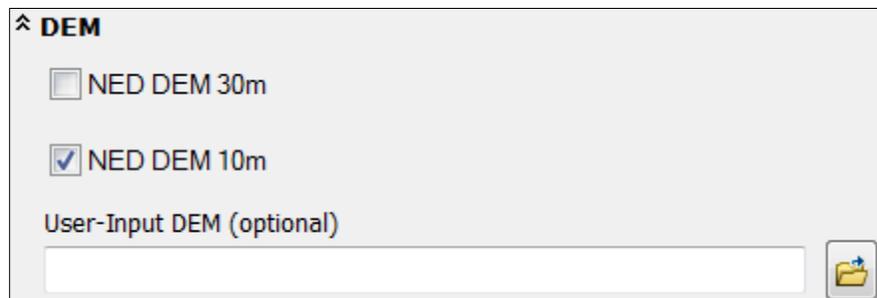
Stream Threshold

1000

7) DEM

The Esri Living Atlas may be used to obtain a 30-meter DEM, which is standard across the United States, or a high-resolution DEM, which is a composite of the best publicly-available DEM in the country. The high-resolution DEM will contain at minimum a 10-meter value from the National Elevation Dataset. More information is available here:

<https://blogs.esri.com/esri/arcgis/2014/07/11/introducing-esris-world-elevation-services/>



^ **DEM**

NED DEM 30m

NED DEM 10m

User-Input DEM (optional)

By selecting the **NED DEM 10m**, a high-resolution DEM will be extracted that contains elevation values (10-meter to 3-meter resolution) from the National Elevation Dataset. In some locations, FEMA LiDAR data is available. A coverage map is available here:

<http://www.arcgis.com/home/item.html?id=3af669838f594b378f90c10f98e46a7f>

NOTE: By selecting the **NED DEM 10m** option, download and processing times will be notably slower when compared to the **NED DEM 30m**.

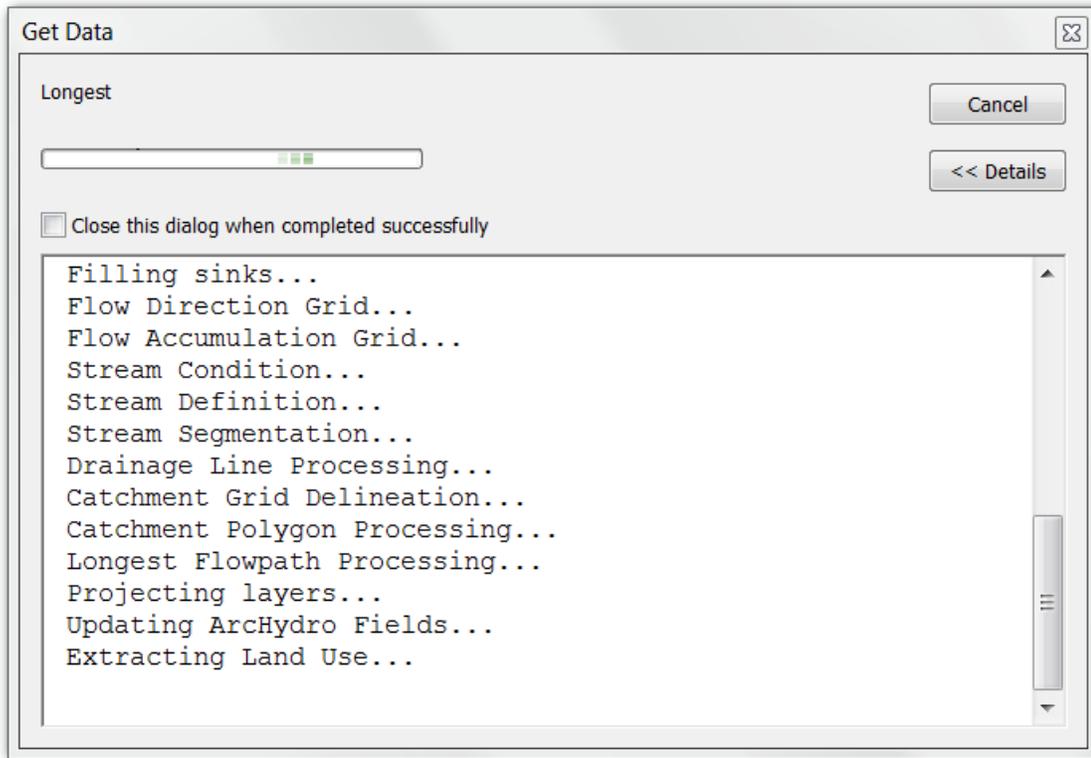
You may also provide your own DEM raster to be used in the HMS-PrePro tool (i.e. LiDAR). When this option is selected, no DEM data will be downloaded from the Living Atlas.

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- 8) Click **OK** to run *Get Data*.

The execution speed will depend on the internet connectivity and watershed size, typically lasting anywhere from 1 to 5 minutes.

You will see a dialog box describing the current processing steps and a status bar. Do not close this box until you see “Completed” at the top.



Once the script has completed, you may navigate to the output folder directory to view the hydrological geodatabase with landscape layers, subbasins, and reaches. Each of these layers may be added to ArcMap for viewing. If you used ArcHydro, the longest flowpath layer will also be available. If you used NHDPlusV2.1, you will have to extract the longest flowpath using separate steps (outlined below).

- [-] Bear.gdb
 - [+] DEM
 - [+] Impervious
 - [+] Land_Use
 - [+] Reach
 - [+] SoilsHSG
 - [+] Subbasin

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9) Longest Flowpath for NHDPlusV2.1: (not required when using the ArchHydro option)

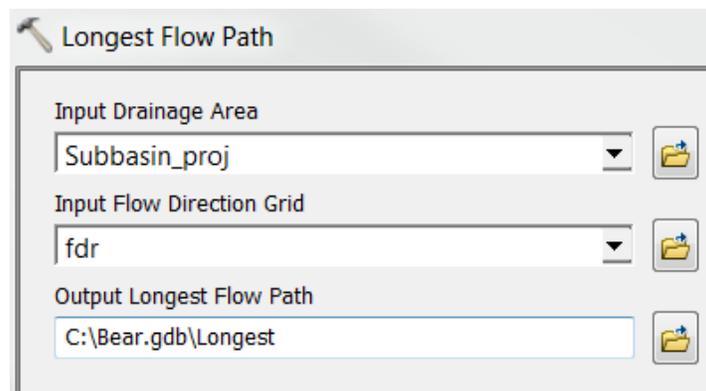
Currently, the NHDPlusV2.1 longest flowpath layer is not included in the Esri Living Atlas. It is anticipated that this layer will become available in future releases.

For now, you will need to extract this layer using the following steps:

- a. Select the HUC-2 hydrological boundary for your area of interest here:
http://www.horizon-systems.com/NHDPlus/NHDPlusV2_data.php
- b. Download the FTP of the **FdrFac** file for your region. Austin is within the 12c region.



- c. **Extract** this file to your computer. You may need **7-zip** or **winzip** to open a .7z extension.
<http://www.winzip.com/landing/open-7z-file.html>
<http://www.7-zip.org/>
- d. **Project** the **Subbasin** layer to the **NAD_1983_Albers** projection using the *Project (Data Management)* tool. This projected layer will only be used to get the longest flowpath.
- e. Open the **Subbasin_proj** layer and add a field called **HydroID** (Long Integer). Populate this field with the **Name** column using *Field Calculator*. Save the map before continuing.
- f. Open ArcCatalog >> Toolboxes >> System Toolboxes >> ArcHydro Tools >> Watershed Processing >> **Longest Flow Path**

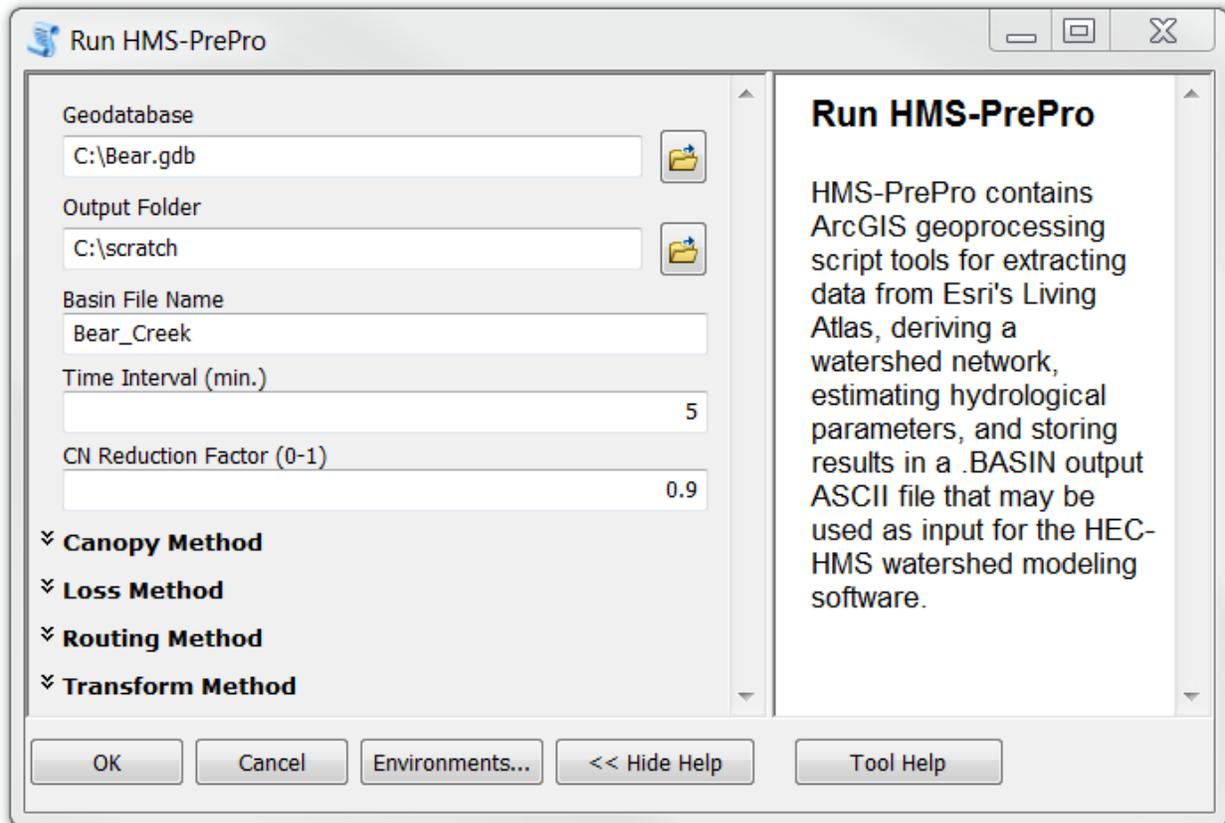


- g. Select the **Subbasin_proj** layer as the *Input Drainage Area*.
- h. Select the **fdr** grid as the *Input Flow Direction Grid*.
- i. Save the output in the "Get Data" geodatabase, and name the layer **Longest**.
- j. Select **OK**.

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Using the HMS-PrePro Run HMS-PrePro Tool

- 1) Double-click on the *Run HMS-PrePro* script



NOTE: If you encounter an error, first try closing out of ArcMap and re-opening a blank project.

- 2) Select the geodatabase created with the *Get Data* tool.
- 3) Select an output folder for the .BASIN HEC-HMS file.
- 4) Choose a name for the .BASIN file.
- 5) Select a time interval (whole number) for the HEC-HMS simulation.
- 6) Choose a Curve Number reduction factor (optional) according to observed/calibrated data. See Castro (2016) for more information.
- 7) You may choose to employ the HEC-HMS **Canopy Method**. See HEC-HMS User's Manual for more information.
- 8) You may choose between the SCS Curve Number loss method or the Green & Ampt loss method. The SCS Curve Number method is recommended for general applications.
- 9) You may select between the Lag Routing method or the Muskingum-Cunge routing method. The Muskingum-Cunge method requires user-input information about the channel.
- 10) This version of HMS-PrePro only contains the SCS Unit Hydrograph transformation method using the Curve Number Lag equation for the lag time (National Engineering Handbook, Chapter 15). The TR-55 lag method, Snyder unit hydrograph method, and Clark unit hydrograph method are available by contacting the author.
- 11) Select **OK**.

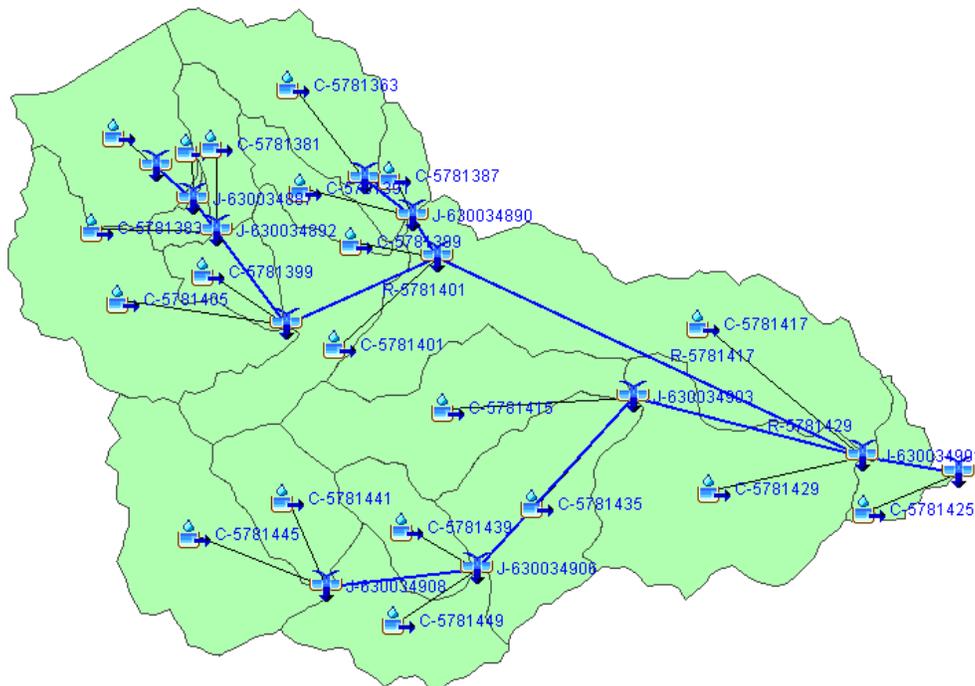
Using HMS-PrePro

Opening .BASIN File in HEC-HMS

Now that you have created a .BASIN file from the hydrological geodatabase, you may use this to *initialize* a HEC-HMS model. Further calibration and engineering optimization is necessary to accurately model the watershed response. These results should not be used for design or judgment purposes without further analysis by a professional engineer.

- 1) Open HEC-HMS version 3.5
Download available: <http://www.hec.usace.army.mil/software/hec-hms/downloads.aspx>
- 2) Create a New Project (File >> New...). Choose the U.S. Customary units.
- 3) Import the .BASIN file (File >> Import >> **Basin Model**).
Navigate to the directory where you saved the .BASIN file in the HMS-PrePro tool.
- 4) In the legend, open the Basin Models folder and select your basin. You may optimize the view by selecting View >> Maximum Extents and changing the percentage value.

You may also import background images (i.e. subbasin, longest flowpath) by selecting View >> Background Maps >> Add. When importing background images to HEC-HMS, the layer cannot be contained in a geodatabase. You will need to export the data as a shapefile first.



- 5) To fully execute a HEC-HMS model, you will need to create a meteorological model, control specifications, and a simulation run. Refer to the HEC-HMS manual for further information.

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Questions

For questions regarding this product, please contact:

Cynthia V. Castro

cynthiavail11@gmail.com

This tool follows principles outlined in Castro, C.V. (2016).

Castro, C.V. (2016). "HMS-PrePro: A GIS Preprocessing Tool for Extracting Geospatial Data and Preparing HEC-HMS Models." M.S. thesis University of Texas, Austin, Texas.