Distributed Precipitation HEC-HMS Model For UTM Map Projection System

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1. Introduction

Understanding the complex relationships between rainfall and runoff process is necessary for the proper estimation of the quantity of the flood peak generated in a watershed. The Hydrologic Engineering Center's Hydrologic Modeling System (HEC-HMS) is a powerful system which is deigned to simulate the rainfall-runoff processes. Hydrographs produced by the program are used directly or in conjunction with other software, for example HEC-RAS, for many hydrological and hydraulic studies such as water availability, urban drainage, flow forecasting, future urbanization impact, reservoir spillway design, flood damage reduction, floodplain regulation, and systems operation.

In the traditional approach of hydrologic modeling, hydrologic parameters were averaged over a large basin. However, these averaged hydrologic parameters cannot represent the details well in a basin, especially for the basin with versatile hydrologic properties. With the availability of radar rainfall and spatial data (digital elevation model and national land cover dataset), hydrologic modeling using smaller subbasin areas or a grid system can introduce a more details to represent the basin as real as possible. By calculating the rainfall and infiltration cell by cell, the gridded HEC-HMS model can provide better accuracy over traditional basin average methods.

In order to prepare input files, datasets, parameters for a HEC-HMS model, we need to utilize two toolkits operating on the ArcMap software, namely HEC-GeoHMS and Arc Hydro. They contain a set of tools specifically designed to process geospatial data, digital elevation model and perform hydrological analysis. Through a user-friendly graphical user interface, which consists of menus, tools, and buttons, and the integrated data management, the user can analyze the terrain information, delineate subbasins and streams, and prepare hydrologic inputs, expediently.

In order to visualize gridded rainfall data and gridded curve number file, HEC-DSSVue is necessary to use. HEC-DSSVue is a Java-based visual utilities program that allows users to plot, tabulate, edit, and manipulate data in a HEC-DSS database file (file_name.dss).

This tutorial introduces and demonstrates the necessary details about how to develop a gridded hydrological model based on the widely used, free-access and open-source software, HEC-HMS. The training of this tutorial will be benefit to the audience who are interested in hydrologic study.

In this tutorial, you will use the following software

- ArcMap 10.X
- HEC-GeoHMS 10.X
- Arc Hydro 10.X
- HEC-DSSVue 3.2.3
- HEC-HMS 4.8.1

Readers are expected to understand some basic knowledge on hydrology and hydraulics as well as the operation skills on the HEC-RAS software, ArcMap, and Windows 10 before reading this tutorial

! The default operational system is Windows 10 and the ArcMap 10.6 is used to prepare this tutorial.

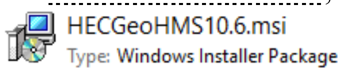
2. Download and Install Required Software

2.1 Download and install HEC-GeoHMS

The link below is for downloading the HEC-GeoHMS. The version of HEC-GeoHMS has to be consistent with the version of ArcMap on your operational desktop. For example, if your ArcMap version is 10.6, then your HEC-GeoHMS has to be 10.6. The name of the install package would be HECGeoHMS10.6.msi in the link provided below.

Link for downloading HECGeoHMS10.6.msi
yellow.esri.com - /archydro/HECGeoHMS/

- ***Direct To*** your download folder, ***Double Click*** on the Windows Installer Package named HECGeoHMS10.6.msi, and follow the instruction to install HEC-GeoHMS.

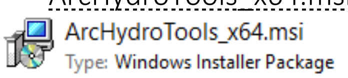


2.2 Download and install Arc Hydro

The link below is for downloading the Arc Hydro. The version of Arc Hydro has to be consistent with the version of ArcMap on your operational desktop. For example, if your ArcMap version is 10.6, then your Arc Hydro has to be 10.6. You might have several versions under the ArcHydro 10.6. Just choose the latest one which is compatible with your Windows (e.g., if your Windows is x64, then you have to choose x64) to download and install. The name of the install package would be ArcHydroTools_x64.msi in the link provided below.

Link for downloading ArcHydroTools_x64.msi
yellow.esri.com - /archydro/ArcHydro/Setup/

- ***Direct To*** your download folder, ***Double Click*** on the Windows Installer Package named ArcHydroTools_x64.msi, and follow the instruction to install Arc Hydro.

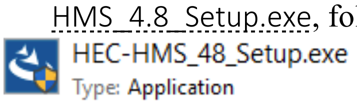


2.3 Download and install HEC-HMS

The link below is for downloading the HEC-HMS. The version we needed in this tutorial shows the following name in the download page,

Link for downloading HEC-HMS 4.8 for Windows (199MB)
https://www.hec.usace.army.mil/software/hec-hms/downloads.aspx

- ***Direct To*** your download folder, ***Double Click*** on the Application named HEC-HMS_4.8_Setup.exe, follow the instruction to install HEC-HMS.



2.4 Download and install HEC-DSSVue

The link below is for downloading the HEC-DSSVue. The version we needed in this tutorial shows the following name in the download page,

Link for downloading HEC-DSSVue 3.2.3 for Windows (66.5 MB)
https://www.hec.usace.army.mil/software/hec-dssvue/downloads.aspx

- ***Direct to*** your download folder, ***double click*** on the Application named HEC-DSSVue_323_Setup.exe, follow the instruction to install HEC-DSSVue.

HEC-DSSVue_323_Setup.exe
Type: Application

2.5 Download the datasets

The links below are for downloading the datasets that you need use in this tutorial. Table 1 below introduces the function of the files in this exercise.

Link for downloading the datasets folder named Tutorial.
https://drive.google.com/drive/folders/1bl7cROjkokxU7w33ol2HtFWFDKs8wUZa?usp=sharing

Table 1. The datasets and files in the tutorial and their functions

CypressDEM.tif	A digital elevation model (DEM) used for hydrologic processing.
CypressCN.tif	A gridded dataset which has Curve Number (CN).
2016 PDIR.dss	A gridded dss file which has rainfall data.
River Lag Time.xlsx	A excel file used to calculate river lag time.
Tools	Tools in the folder used to generate gridded CN dss file.
asc2dssGrid.exe	An executable program used for transferring ASCII format dataset to dss format dataset.
CN ASC2DSS Project.bat	A script file contains commands to project the coordinate system.

- ***Store*** the Tutorial folder under the C drive. The location looks like following,

  > This PC > Local Disk (C:) > Tutorial >

2.6 Others

In addition, this tutorial also provides some useful reading materials for whom is interested in learning more details.

Link for downloading the reading materials
https://drive.google.com/drive/folders/1wP6ypF5rMkidKISdmJSaOsEn-quRGtE-?usp=sharing

For how to generate the gridded rainfall dss file, please see the link below https://web.eng.fiu.edu/arleon/Code_Precip_Forecast_DSS.html

If you are not familiar with the user interface of ArcMap and HEC-HMS, please see the Appendix 1 and 2 first. If you are familiar with the user interface of these two software, you are ready to go.

Now we are ready to explore how to build a gridded HEC-HMS model.

3. Prepare a basin model for HEC-HMS

In this section, we are going to use HEC-GeoHMS to prepare a gridded basin model. Before processing datasets, we need to setup the ArcMap for running HEC-GeoHMS.

3.1 Presetting the ArcMap and Add Datasets

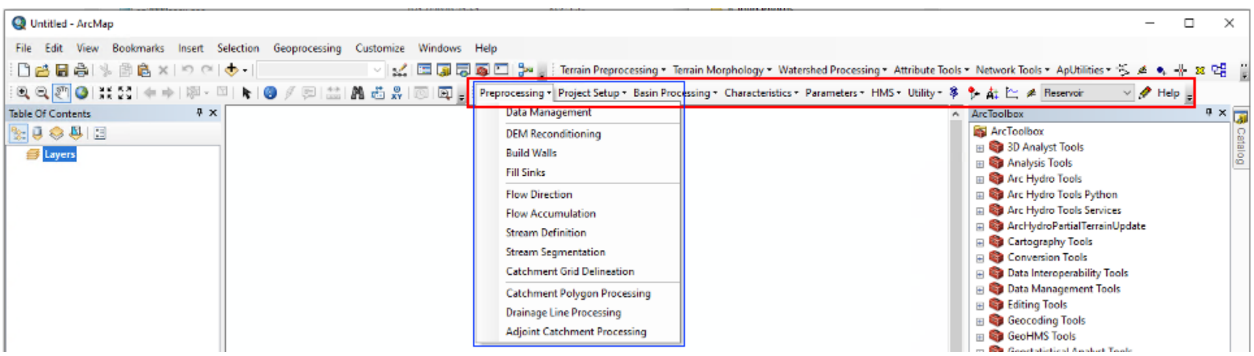
📝 For your convenience, those who are not familiar with ArcMap read Appendix first please.

- ***Open*** ArcMap 10.6.

In ArcMap Menu,

- ***Click*** Customize ☞ Extensions, ***Check*** Spatial Analyst, ***Click*** Close.
- ***Click*** Geoprocessing ☞ Geoprocessing Options…, in Geoprocessing Options window Background Processing option, ***Uncheck*** Enable, ***Click*** Ok.
- ***Right click*** on the blank space (Next to Help), ***Click to Check*** HEC-GeoHMS and Arc Hydro Tools.

Now you can see HEC-GeoHMS Menu and Arc Hydro Tools Menu in the ArcMap user surface.



HEC-GeoHMS Menu has 7 tabs, namely Preprocessing, Project Setup, Basin Processing, Characteristics, Parameters, HMS, and Utility. Under each of tabs there are a series of tools. Normally, the dataset processing needs to follow a certain sequence. Fortunately, the sequence of datasets processing is already organized by HEC-GeoHMS Menu from left tab (Preprocessing) to right tab (Utility) from the top tool (Data Management) to bottom tool (Adjoint Catchment Processing) under the each of tab.

The initial step always begins with adding the datasets we need to process.

In ArcMap Standard Menu

- ***Click*** ✚▾ (Add Data), in Add Data window, Click (Connect To Folder), ***Navigate To*** and ***Select*** the Tutorial folder, ***Click*** Ok, ***Select*** CypressDEM.tif, ***Click*** Add.
- ***Click*** (Save), in Save As window, Save in: ***Choose*** Tutorial folder, File Name: **Type** CypressMap, Save as type: ***Choose*** ArcMap Document (*.mxd), ***Click*** Save.

Now, we will dig into the real business for building a gridded HEC-HMS model.

3.2 Preprocessing

Terrain preprocessing marks the first step in developing an HEC-GeoHMS project. In this step, a terrain model (digital elevation model) is used as an input to derive eight additional datasets that collectively describe the drainage pattern of the watershed and allows for stream and subbasin delineation.

❗ Please keep the saving location as default during this process

In HEC-GeoHMS Menu

- ***Click*** Preprocessing

☞ Fill Sinks, in Input DEM ***Click*** ▾ ***Choose*** CypressDEM.tif, ***Click*** Ok, when Fill Sinks window shows Completed, ***Click*** Close.
☞ Flow Direction, ***Click*** Ok, when Flow Direction window shows Completed, ***Click*** Close.
☞ Flow Accumulation, ***Click*** Ok, when Flow Accumulation window shows Completed, ***Click*** Close.
☞ Stream Definition, ***Click*** Ok, when Stream Definition window shows Completed, ***Click*** Close.
☞ Stream Segmentation, ***Click*** Ok, Stream Segmentation window shows Completed, ***Click*** Close.
☞ Catchment Grid Delineation, ***Click*** Ok, when Catchment Grid Delineation window shows Completed, ***Click*** Close.
☞ Catchment Polygon Processing, ***Click*** Ok, when Catchment Polygon Processing window shows Completed, ***Click*** Close.
☞ Drainage Line Processing, ***Click*** Ok, when Drainage Line Processing window shows Completed, ***Click*** Close.
☞Adjoint Catchment Processing, ***Click*** Ok, when Adjoint Catchment Processing window shows Completed, ***Click*** Close.

Now you finished the Preprocessing

3.3 Project Setup

The HEC-GeoHMS Project Step menu has tools for defining the outlet for the watershed and delineating the watershed for the HEC-HMS project. The location of the outlet represents the downstream boundary for the HEC-HMS project. After defining the downstream outlet, HEC-GeoHMS will extract data from the datasets created using the tools in the Preprocessing menu (introduced in 2.1) for the watershed area (drainage area) upstream of the outlet.

In HEC-GeoHMS Menu

- ***Click*** Project Setup

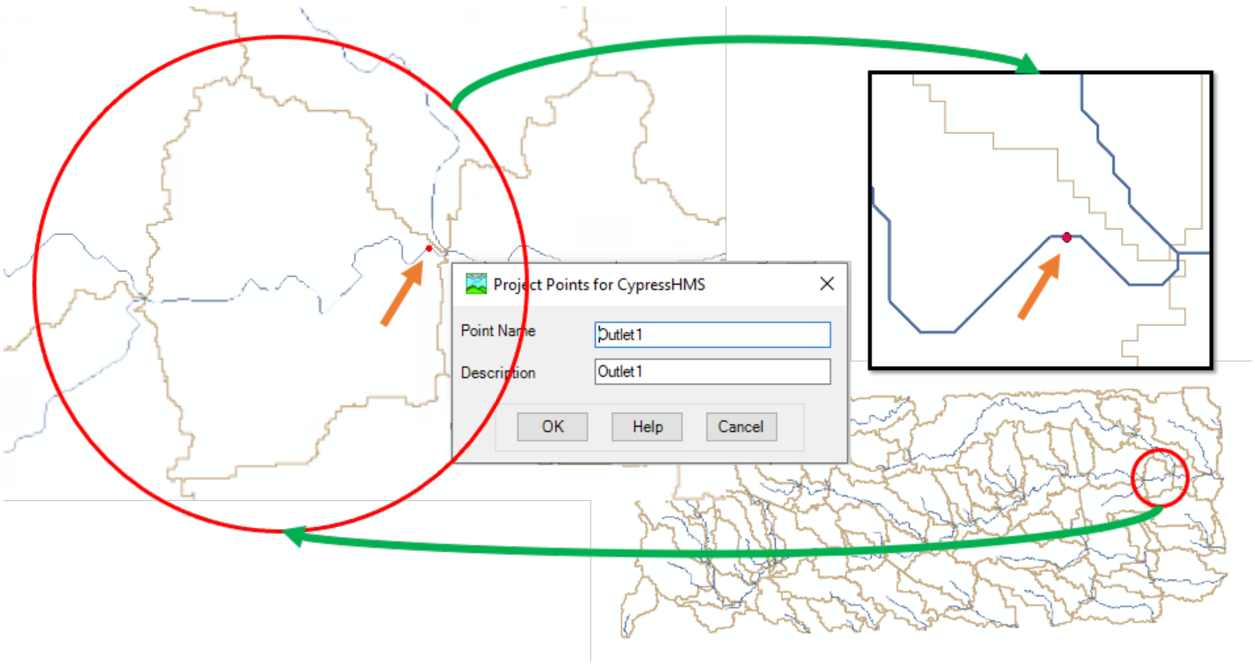
☞ Data Management, in Data Management window Raw DEM, ***Choose*** CypressDEM.tif, leave other parameter as default, ***Click*** Ok.

📝This is the reason why I would recommend you leave the name as default in the Section 2.1 Preprocessing. In such way, you will not need to set up the default datasets for each other parameters in the following section. Therefore, I strongly recommend using Data Management to decrease your unnecessary workload.

☞ Start New Project, in Start New Project window, leave the name of Project Area and Project Point as default, ***Click*** OK. In the pop-out Define A New Project window Project Name ***Type in*** Cypress, Description ***Type in*** This is Cypress Creek HEC HMS model. Leave other options as default, ***Click*** OK. In the pop-out Start New Project window, please ***Read*** the window and ***Click*** OK.

- In ArcMap Table of Contents, ***Uncheck*** other datasets except ProjectPoint, ProjectArea, DrainageLine, and Catchment.
- ***Zoom-in*** to the location as shown in the figure below in the **red cycle**, in HEC-GeoHMS Menu, ***Click*** (Add Project Points), and ***Click*** on the location of **red dot** as shown in the figure below, in Project Point for Cypress window, leave the Point Name and Description in as default, and ***Click*** OK.

❗ The red dot cannot go outside of the outline of the sub-catchment. Otherwise, the study watershed will be the different.



- ***Click*** Project Setup ☞ Generate Project. In the pop-out Generate Project window, ***Click*** Yes. In the pop-out Generate Project window, ***Click*** OK. When Generate Project shows Generate Project successfully completed., ***Click*** Ok.

📝This process needs few minutes. You will get a new Data Frame called Cypress in ArcMap Table of Contents.

3.4 Basin Processing

We don't perform basin processing in this tutorial. The details can be found in the User manual of HEC-GeoHMS

3.5 Characteristics

HEC-GeoHMS computes several topographic characteristics of streams and subbasins that can be used for estimating hydrologic parameters. This section will discuss the tools for extracting topographic characteristics of streams and subbasins. These tools are available from the Characteristics tab on the HEC-GeoHMS Menu.

In HEC-GeoHMS Menu

- ***Click*** Characteristics

☞ Data Management, you will find Slope Grid shows Null, ***Click*** Ok.
Now we need to generate watershed slope gridded file.

In Arc Hydro Menu

Click Terrain Preprocessing ☞ Slope, in Raw DEM ***Select*** RawDEM, ***Click*** OK. When Slope windows shows Slope successfully completed., ***Click*** OK.

In HEC-GeoHMS Menu

- ***Click*** Characteristics

☞ Data Management, in Slope Grid ***Select*** WshSlope, ***Click*** Ok.
☞ River Length, ***Click*** OK. When River Length windows shows Completed, ***Click*** Close.
☞ River Slope, ***Click*** OK. When River Slope windows shows Completed, ***Click*** Close.
☞ Basin Slope, ***Click*** OK. When Basin Slope windows shows Completed, ***Click*** Close.
☞ Longest Flowpath, ***Click*** OK. When Longest Flowpath windows shows Completed, ***Click*** Close.

[You might want to add Longest Flowpath in the Cypress Data Frame. In ArcMap Standard Menu, ***Click*** , ***Navigate to*** the location Tutorial ☛ Cypress folder ☛ Cypress.gdb ☛ Cypress, ***Select*** LongestFlowPath###, ***Click*** Add.]

☞ Basin Centroid, ***Click*** OK. When Basin Centroid windows shows Completed, ***Click*** Close.
☞ Centroid Elevation, ***Click*** OK. When Basin Elevation windows shows Completed, ***Click*** Close.
☞ Centroidal Longest Flowpath, ***Click*** OK. When Centroidal Longest Flowpath windows shows Completed, ***Click*** Close.

3.6 Parameters

After the physical characteristics of streams and subbasins have been extracted, a number of hydrologic parameters need estimate. Tools on the Parameters menu will populate the attribute tables for the subbasin and river layers. This information will be contained in the HEC-HMS model file generated by HEC-GeoHMS, thus saving the user time when parameterizing the model. This section will discuss the tools for estimating hydrologic parameters that are available from the Parameters tab.

In HEC-GeoHMS Menu

- ***Click*** Parameters

☞ Data Management, ***Inspect*** all the parameters are not null and be consistent with the datasets, ***Click*** OK.

☞ Select HMS Process,

In Subbasin – Loss Method, ***Choose*** SCS;
In Subbasin – Transform Method, ***Choose*** None;
In Subbasin – Baseflow Method, ***Choose*** None
In River – Route Method, ***Choose*** Lag;
Click OK. When Select HMS Processes windows shows Completed, ***Click*** Close.

Currently we choose SCS as Loss Method because we need to generate the gridded Curve Number datasets (CN.dss) for HEC-HMS model. The Loss Method will later revise to gridded SCS method in the HEC-HMS.

☞ River Auto Name, ***Click*** OK. When River Auto Name windows shows Completed, ***Click*** Close.
☞ Basin Auto Name, ***Click*** OK. When Basin Auto Name windows shows Completed, ***Click*** Close.
☞ Grid Cell Processing, in Select the grid cell method: ***Check*** SHG, in SHG Parameters ☞ Select SHG grid cell: ***Choose*** 2000, ☞ Select the project: ***Click*** Change…
Navigate to Projected Coordinate Systems ☛ UTM ☛ WGS 1984 ☛ Northern Hemisphere ☛ WGS 1984 UTM Zone 14N, ***Click*** OK, in Grid Cell Processing window, ***Click*** OK. In the pop-out Grid Cell Processing window, ***Click*** OK. In the pop-out Grid Cell View window, ***Click*** OK. When Grid Cell Processing windows shows Completed, ***Click*** Close.

This process needs few minutes. You will get a new shape file named GridCellIntersect### in Cypress Data Frame in ArcMap Table of Contents.

Now we need to generate the data for the basin concentration time.

☞ TR55 Flow Path Segments, in the pop-out window, ***Click*** OK. When TR55 Flow Path Segments windows shows Completed, ***Click*** OK.
☞ TR55 Flow Path Parameter, in the pop-out window, ***Click*** OK. In the pop-out Unite Conversion window, ***Click*** OK. When TR55 Flow Path Parameter windows shows Completed, ***Click*** OK.
☞ TR55 Export to Excel, in the pop-out TR55 Export to Excel window, ***Click*** OK. ***Close*** and ***Save*** the Excel for now.

The excel is automatically stored at the Tutorial folder in your C drive. e.g., C:\Tutorial\XLSFiles\Tc_20210529155818.xls

☞ CN Lag, in the pop-out CN Lag window, ***Click*** OK.

3.7 HMS

This section will discuss the tools for generating HEC-HMS model files.

In HEC-GeoHMS Menu

- Click HMS

☞Map to HMS Units, in the pop-out window, ***Click*** OK. In the pop-out Select unit type for HMS Model window, Select the Unit type for HMS Unit Conversion, ***Choose*** SI. ***Click*** OK. When Map to HMS Units windows shows Completed, ***Click*** OK.

☞ Check Data, ***Click*** OK. In the pop-out Check Data window, **Click** No to not see the logfile.

☞ HMS Schematic, ***Click*** OK. When HMS Schematic windows shows HMS Schematic is created., ***Click*** OK.

☞ Toggle Legend ☞ HMS Legend.

☞ Add Coordinates, ***Click*** OK, in Unit Conversion window, ***Click*** OK. When Add Coordinates window shows Add Coordinates successfully completed, ***Click*** OK.

☞ Prepare Data for Model Export, ***Click*** OK, in pop-out Prepare Data for Model Export window, ***Click*** Yes. When Prepare Data for Model Export window shows Prepare Data for Model Export successfully completed, **Click** OK.

☞ Background Shape File, ***Click*** OK. When Background Shape File window shows Background Shape File successfully completed, ***Click*** OK.

☞ Basin Model File. When Basin Model File window shows GIS data exported successfully for Basin Model File function! Basin file location=C:\Tutorial\Cypress\Cypress.basin, ***Click*** OK.

☞ Grid Cell File. When Grid Cell File window shows GIS data exported successfully for Grid Cell File function! Grid Cell File =C:\Tutorial\Cypress\Cypress.mod, ***Click*** OK.

Now you have a basin file named Cypress.basin which is used for HEC-HMS model. And you have a grid cell file named Cypress.mod which is the important input data for a gridded HEC-HMS model. Once we reach to this point, we are close to finished.

3.8 Utility

Tools available from the Utilities menu assist in the estimation of hydrologic parameter. In this section we will discuss how to use the tools in the Utility to generate the gridded curve number file which uses as input for Loss Method of gridded SCS in the HEC-HMS.

Since we need to use gridded SCS method, we need to add the Curve Number for each cell of the basin. (The cell in the dataset named GriddCellIntersect###)

In ArcMap Table of Contents

- ***Click*** (Add Data), ***Click*** C:\ in Look in: ***Navigate to*** the folder Tutorial, ***Select*** CypressCN.tif, ***Click*** Add.

In HEC-GeoHMS Menu

- ***Click*** Parameter ☞ subbasin Parameters From Raster, in Input Subbasin, ***Click***, ***Choose*** GridCellIntersect###, in Input Curve Number Grid (optional), ***Click***, ***Choose***

CypressCN.tif, and ***Click*** OK. When Subbasin Parameters From Raster shows Completed, ***Click*** Close.

Now if you open the attribute table of the GridCellIntersect (as the command below), you will find there is a number in the column of BasinCN.

- In ArcMap Table Of Contents, Cypress data frame, ***Right Click*** GridCellIntersect###, ***Click*** Open Attribute Table, ***See*** the value in BasinCN column,

Now we need to generate gridded CN in ASCII, and use ASCII to generate DSS format. It should be noticed that HEC-HMS only can read data in DSS format.

In HEC-GeoHMS Menu

- ***Click*** Utility ☞ Generate ASCII Grid, in Select parameter tag to create ASCII grid, ***Click*** ▾, ***Choose*** Curve Number, in Input Grid Cell Intersection, ***Click*** ▾, ***Choose*** GridCellIntersect###, and ***Click*** OK. When Generate ASCII Grid window shows Completed, ***Click*** Close.

In Section 3.8.1 introduce the procedures that only works for HEC-HMS version **lower than** 4.8. If you use HEC-HMS 4.8 please go to Section 3.8.2

3.8.1 Generate grid CN for HEC HMS version lower than 4.8

- Open Tutorial folder, ***Right Click*** ☛ New ☛ Text Document. **Rename** New Text Document.txt **as** GridCN.dss

In HEC-GeoHMS Menu

- ***Click*** Utility ☞ Generate DSS from ASCII Grid, in Input ASCII Grid File, ***Click*** , Navigate to location Tutorial ☛ Cypress ☛ Cypress, ***Select*** CNGrid.asc. In Input DSS Part C, **Choose** CURVE NUMBER, ***Click*** Open, in Input DSS Data Unit, ***Choose*** UNDEF. In Output DSS File, ***Click*** , ***Navigate to*** Tutorial, ***Select*** GridCN.dss, ***Click*** Open, and then ***Click*** OK. When Generate DSS from ASCII Grid Completed. Click Close.

The DSS file store at the location: C:\Tutorial\GridCN.dss

3.8.2 Generate grid CN for HEC HMS 4.8

The method describe in Section 3.8.1 cannot change the spatial reference. However, our basin model and precipitation model use UTM 14N as spatial reference. And HEC-HMS 4.8 has higher error check requirements. Therefore, we need to project our GridCN.asc file into UTM 14N spatial reference.

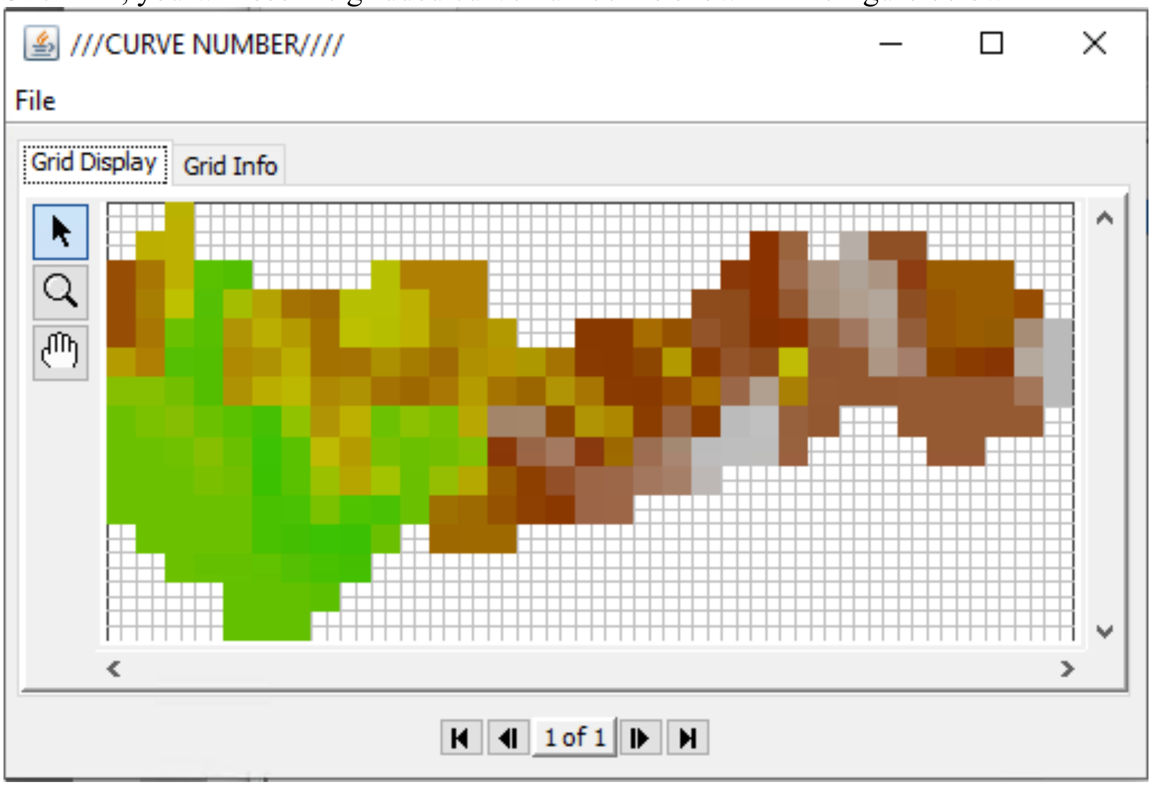
- ***Open*** the Tutorial folder ☛ Cypress ☛ Cypress, ***Copy*** CNGrid.asc ***to*** the Tutorial folder ☛ Tools. Then, ***Double Click*** CN ASC2DSS Project.bat, a dss file named CNGrid.dss will automatically generated.

You can use HEC-DSSVue to check the GridCN.dss file

- ***Open*** HEC-DSSVue. Click , Navigate to HMS ☞ Tools, Select CNGrid.dss, Click Open. Select DSS path as shown in the figure below

Number	Part A	Part B	Part C	Part D / range	Part E	Part F
1			CURVE NUMBER			

Click , you will see the gridded curve number as shown in the figure below



4. Build HEC-HMS model

4.1 Prepare data for ModClark method

- ***Open*** the excel file we generated in the section 3.6. The location should look like C:\Tutorial\XLSFiles\Tc_20210529155818.xls

In our research area, Two-Year 24-hour Rainfall is 4.90 inches. (Details can be seen in the Appendix)

- ***Fill*** 4.90 in the Raw 8 (Two-Year 24-hour Rainfall (in)) for every subbasin.
- ***Check*** in Row 9 (Land Slope) and Row 21 (Channel Slope), If a value is smaller and equal to 0, please ***Revise*** it into 0.0001
- ***Click*** to generate a new sheet and ***Name*** it HMS. ***Name*** table title as Subbasin, Tc, R.

	1	2	3
1	Subbasin	Tc	R
2			
3			

- In Tc sheet***, Copy*** Row 3 and 26 into HMS sheet Subbasin and Tc columns.
- In HMS sheet, Fill in the column R by the following equation.

$$\frac{R}{T_c + R} = 0.65$$

Therefore,

$$R = \frac{13}{7} T_c$$

- Save the excel. It will be use later.

Details can be read in the following link.
https://www.hec.usace.army.mil/confluence/hmsdocs/hmsguides/estimating-clark-unit-hydrograph-parameters/estimating-time-of-concentration-storage-coefficent

4.2 Prepare data for Lag routing method

In this tutorial you will apply the HEC-HMS Lag routing method to a modeling application. Initial parameter estimates will use GIS. The travel time of a flood waving moving through a reach can also be estimated by dividing the length of the reach, L, by the flood wave velocity Vw

$$T = \frac{L}{Vw}$$

To estimate a flood wave velocity, Manning's Equation can be used

$$v = \frac{1}{n} \cdot R^{\frac{2}{3}} \cdot S^{\frac{1}{2}}$$

Details can be read in the following link,
https://www.hec.usace.army.mil/confluence/hmsdocs/hmsguides/applying-reach-routing-methods-within-hec-hms/applying-the-lag-routing-method

In ArcMap Table Of Contents

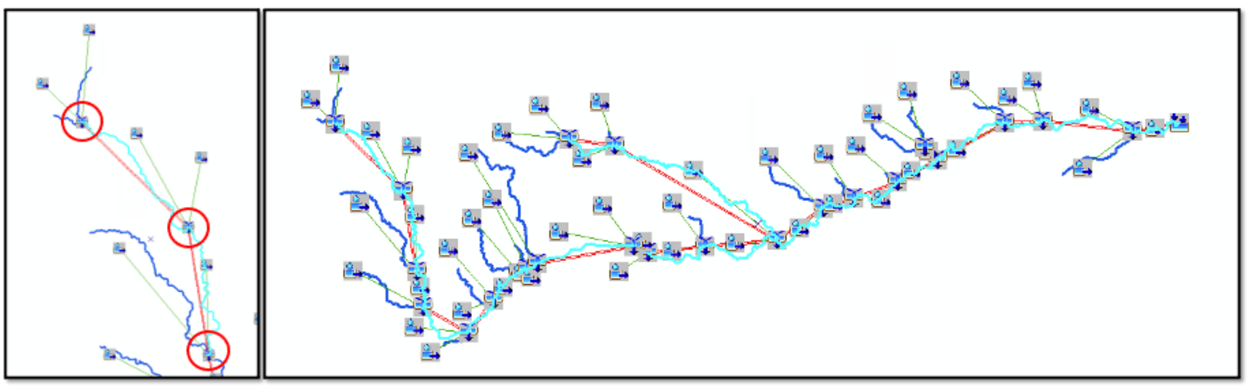
- In Cypress Data Frame, ***Keep*** the following sequence by ***Selecting*** and ***holding*** a layer and ***moving*** that.

HMSNode### ➡ HMS Link### ➡ River### ➡ GridCellIntersect###

- ***Right Click*** River### ☛ Edit Features ☛ Start Editing,

In ArcMap Window

- ***Click*** the River between two Junction points.
- ***Press*** and ***Hold*** Shift key on keyboard, and ***Select*** all the reach between two Junction points from upstream to downstream, details can be seen in the figure below

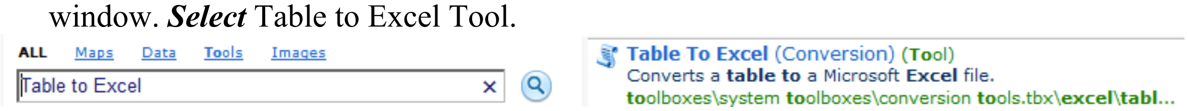


In ArcMap Table Of Contents

- ***Right Click*** River### ☛ Open Attribute Table, you can See the Selected Reach is highlighted. In Table window, ***Click*** ☛ Export…, In the pop-out Export Data window, in Export: make sure Select records is chosen; in Output table: ***Click*** , in Save as type, ***Select*** Text File. In Name: ***Type*** River Lag.txt, ***Click*** Save. In the Export Data window, ***Click*** OK. In the pop-out ArcMap window, ***Click*** Yes.

- In Editor Menu (as shown in the figure below), ***Click*** Editor ☞ Stop Editing.

- In keyboard ***Press*** Ctrl + F , Search window will pop out. ***Type*** Table to Excel in search window. ***Select*** Table to Excel Tool.



- In Table to Excel window, in Input Table, ***Click*** , ***Select*** River_Lag.txt. In Output Excel File, ***Click*** , ***Navigate to*** in the Tutorial folder, in File name: ***Type*** River Lag Data, and ***Click*** Save, and then ***Click*** OK. ***Click*** Close.

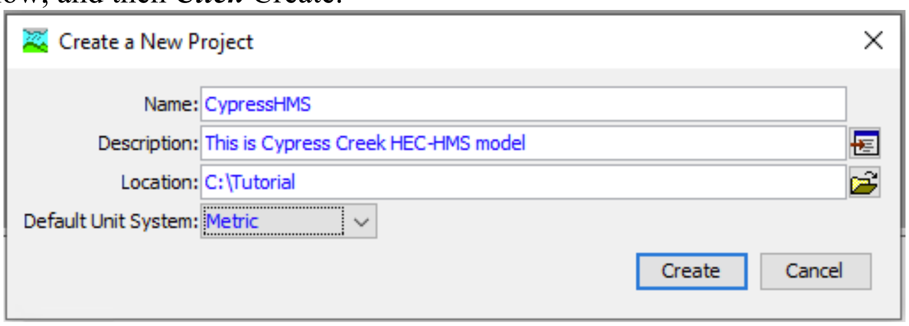
In Windows File Explorer

- ***Navigate to*** Tutorial folder, ***Open*** River Lag Data.xls and River Lag Time.xlsx.
- ***Copy*** Name column in River Lag Data.xls ***to*** River Name column in River Lag Time.xlsx.
- ***Copy*** Slp column in River Lag Data.xls ***to*** Slope column in River Lag Time.xlsx
- ***Copy*** Shape_Length in River Lag Data.xls ***to*** Length column in River Lag Time.xlsx

- ***Save*** River Lag Time.xlsx. It will be use later.

4.3 Compose gridded HEC-HMS model

- ***Open*** HEC-HMS 4.8, ***Click*** (Create a New Project), ***Input*** the information as shown in figure below, and then ***Click*** Create.



- ***Click*** File ☞ Import ☞ Basin Model…. In Look in: Navigate to Tutorial ☞ Cypress, ***Select*** Cypress.basin, ***Click*** Select.

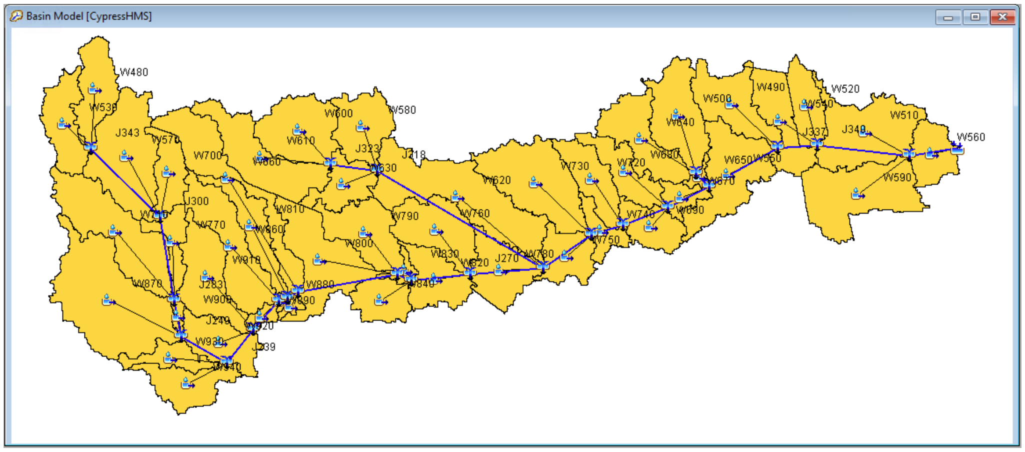
In Watershed Explorer

Click Cypress, a HEC-HMS scheme will show at HEC-HMS window

In HEC-HMS Menu

- ***Click*** View ☞ Map Layers, ***Click*** Add…, in Cypress folder, ***Select*** Subbasin.shp, ***Click*** Select. In the pop-out Basin Model Coordinate System window, ***Click*** Skip.
- In Map Layers, ***Click*** Draw Properties…, in Color, ***Choose*** orange, ***Click*** OK. ***Click*** in Map Layers window.

You will see the watershed in the Basin Model window, which as shown in the figure below



- ***Click*** Components ☞ Create Component

☞ Meteorologic Model…. In Create A New Meteorologic Model window, leave as default, ***Click*** Create. Click ✕ in In Create A New Meteorologic Model window.

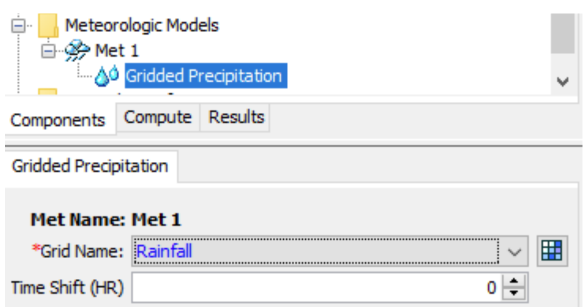
☞ Control Specifications…. In Create A New Control Specifications window, leave as default, ***Click*** Create. Click ✕ in In Create A New Control Specifications window.

☞ Grid Data…. In Create A Parameter Grid Data window, in Name: ***Type*** Rainfall, in Data Type: ***Choose*** Precipitation Gridsets. ***Click*** Create. Click ✕ in In Create A Parameter Grid Data window.

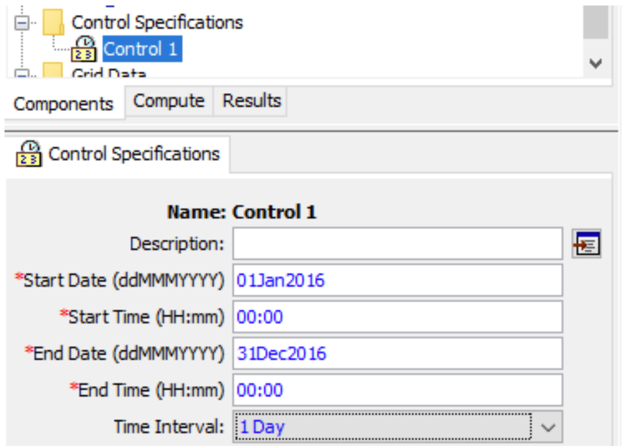
☞ Grid Data…. In Create A Parameter Grid Data window, in Name: ***Type*** CNGrid, in Data Type: ***Choose*** SCS Curve Number Grids. ***Click*** Create. Click ✕ in In Create A Parameter Grid Data window.

In Watershed Explorer

- ***Click*** Meteorologic Models ☞ Met 1, in Component Editor Meteorology Model tab Precipitation ***Choose*** Gridded Precipitation, Replace Missing ***Choose*** Set to Default. Basin tab Include Subbasins, ***Choose*** Yes.
- ***Click*** Gridded Precipitation, in Component Editor Gridded Precipitation tab, Grid Name ***Choose*** Rainfall.

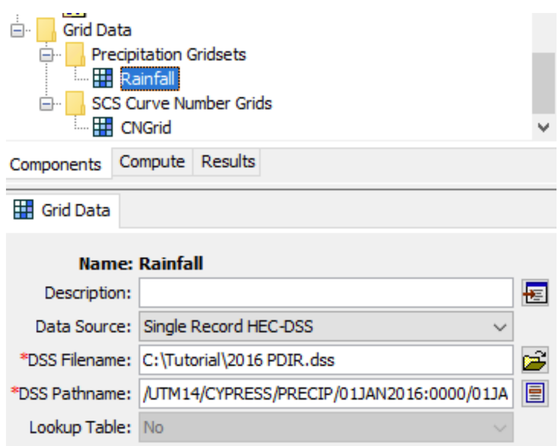


- ***Click*** Control Specifications ☞ Control 1, in Component Editor Control Specifications tab, ***Fill in*** the information as shown in the figure below



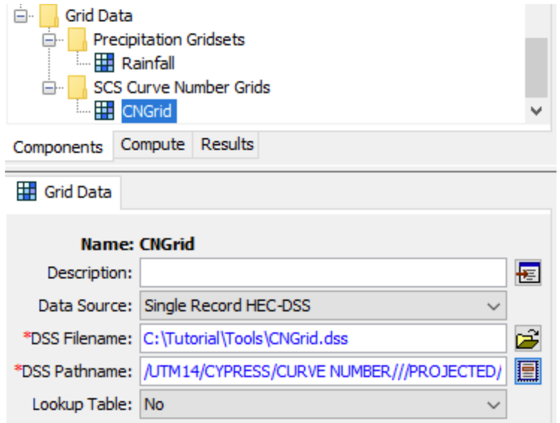
- ***Click*** Grid Data ☞ Precipitation Gridsets ☞ Rainfall, in DSS Filename, ***Click*** , ***Navigate to*** Tutorial folder, ***Select*** 2016 PDIR.dss. in DSS Pathname: Click , in pop-out Select Pathname From HEC-DSS File window, ***Select*** the first row as shown in the figure below, and then ***Click*** Set Pathname.

Number	Part A	Part B	Part C	Part D / range	Part E	Part F
1	UTM14	CYPRESS	CURVE NUMB...			PROJECTED



- ***Click*** Grid Data ☞ SCS Curve Number Grid ☞ CNGrid, in DSS Filename, ***Click*** , ***Navigate to*** Tutorial folder ☛ Tool, ***Select*** CNGrid.dss. in DSS Pathname: ***Click*** , in pop-out Select Pathname From HEC-DSS File window, ***Select*** the first row as shown in the figure below, and then ***Click*** Set Pathname.

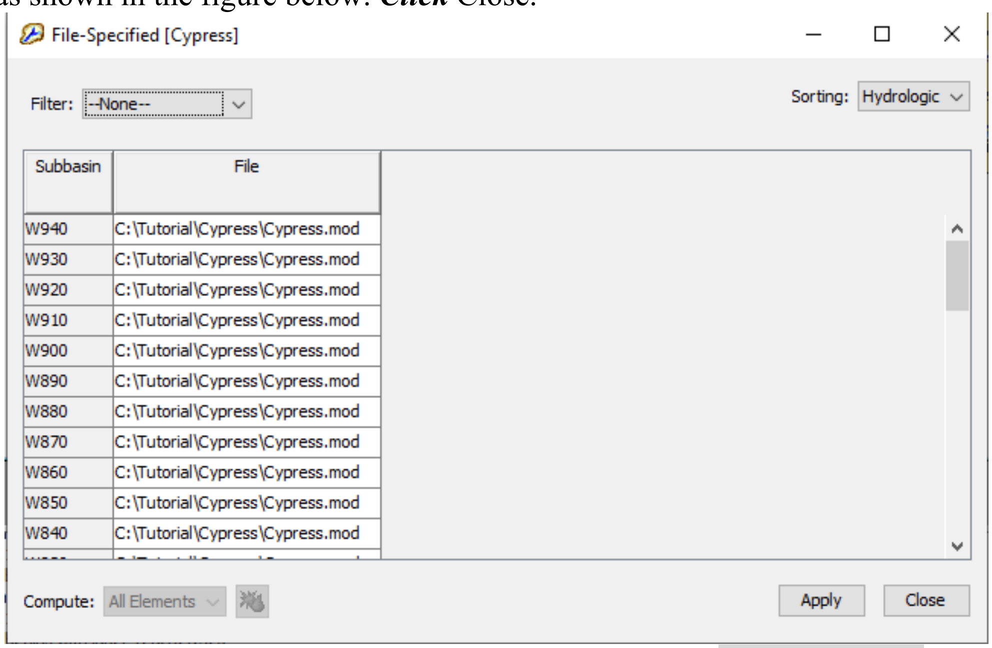
Number	Part A	Part B	Part C	Part D / range	Part E	Part F
1	UTM14	CYPRESS	CURVE NUMBER			PROJECTED



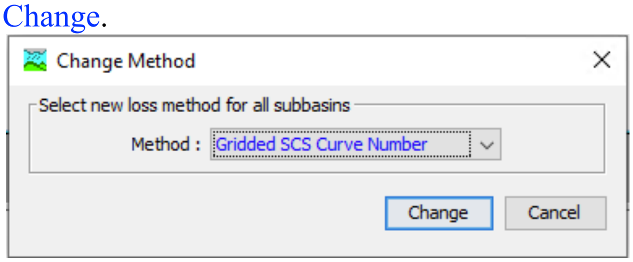
- ***hoose*** Gridded Precipitation, Replace Missing ***Choose*** Set to Default. Basin tab Include Subbasins, ***Choose*** Yes.

In HEC-HMS Menu

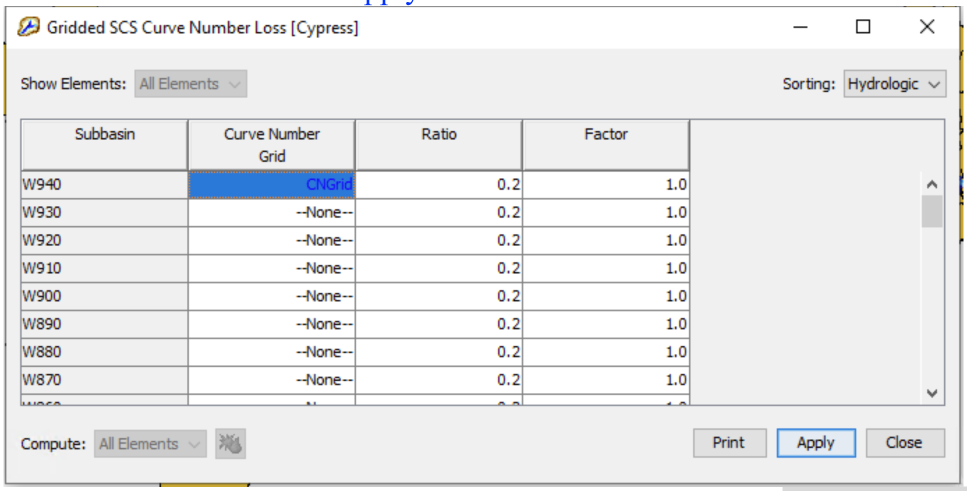
- ***Click*** Parameter ☞ Discretization ☞ File-Specified, ***Check*** File Path in each subbasin is as same as shown in the figure below. ***Click*** Close.



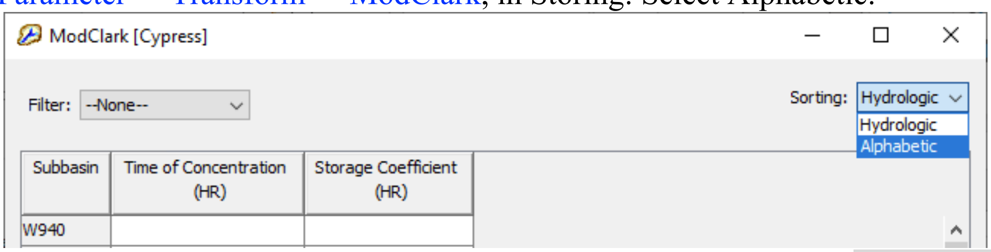
- ***Click*** Parameter ☞ Loss ☞ Change Method…, in the pop-out Change Method window, ***Click*** Yes.
  In Change Method window, Select new loss method for all subbasins ***Select*** Gridded SCS Curve Number, ***Click*** Change.



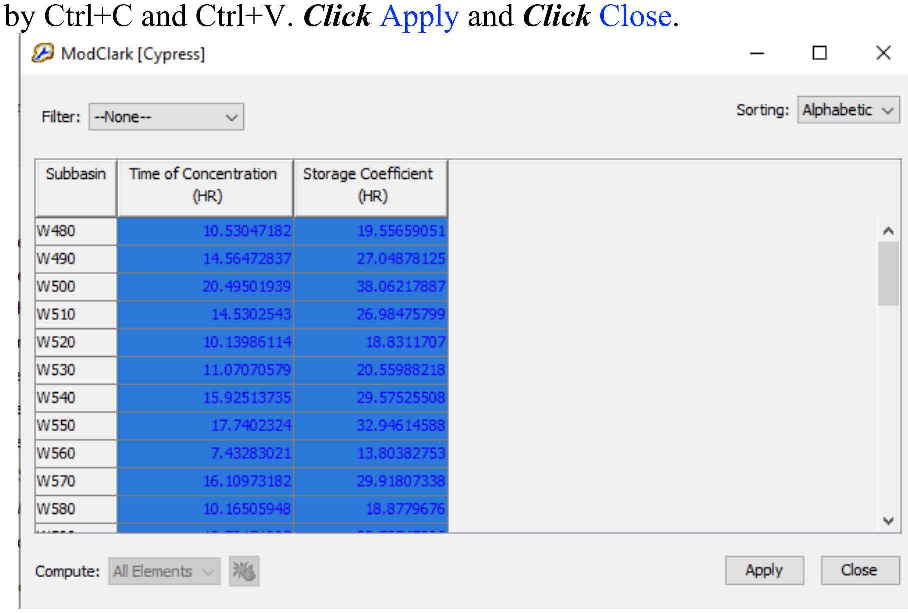
- ***Click*** Parameter ☞ Loss ☞ Gridded SCS Curve Number, in Curve Number Grid column, ***Select*** CNGrid for each Subbasin. ***Click*** Apply and ***Click*** Close.



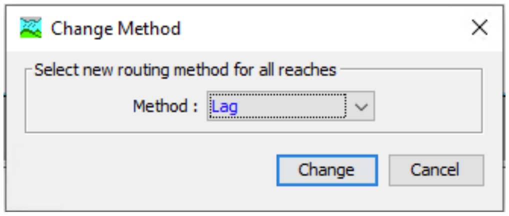
- ***Click*** Parameter ☞ Transform ☞ Change Method…, in the pop-out Change Method window, ***Click*** Yes.
  In Change Method window, Select new transform method for all subbasins ***Select*** ModClark, ***Click*** Change.
- ***Click*** Parameter ☞ Transform ☞ ModClark, in Storing: Select Alphabetic.



- ***Copy*** the data in the excel HMS sheet located at Tutorial ☛ XLSFiles to ModClark [Cypress] window by Ctrl+C and Ctrl+V. ***Click*** Apply and ***Click*** Close.



- ***Click*** Parameter ☞ Routing ☞ Change Method…, in the pop-out Change Method window, ***Click*** Yes.
  In Change Method window, Select new routing method for all reaches ***Select*** Lag, ***Click*** Change.



- ***Click*** Parameter ☞ Routing ☞ Lag.
- ***Copy*** the data in the River Lag Time excel Lag Time (min) row located at Tutorial to Lag Routing [Cypress] window by Ctrl+C and Ctrl+V. ***Click*** Apply and ***Click*** Close.

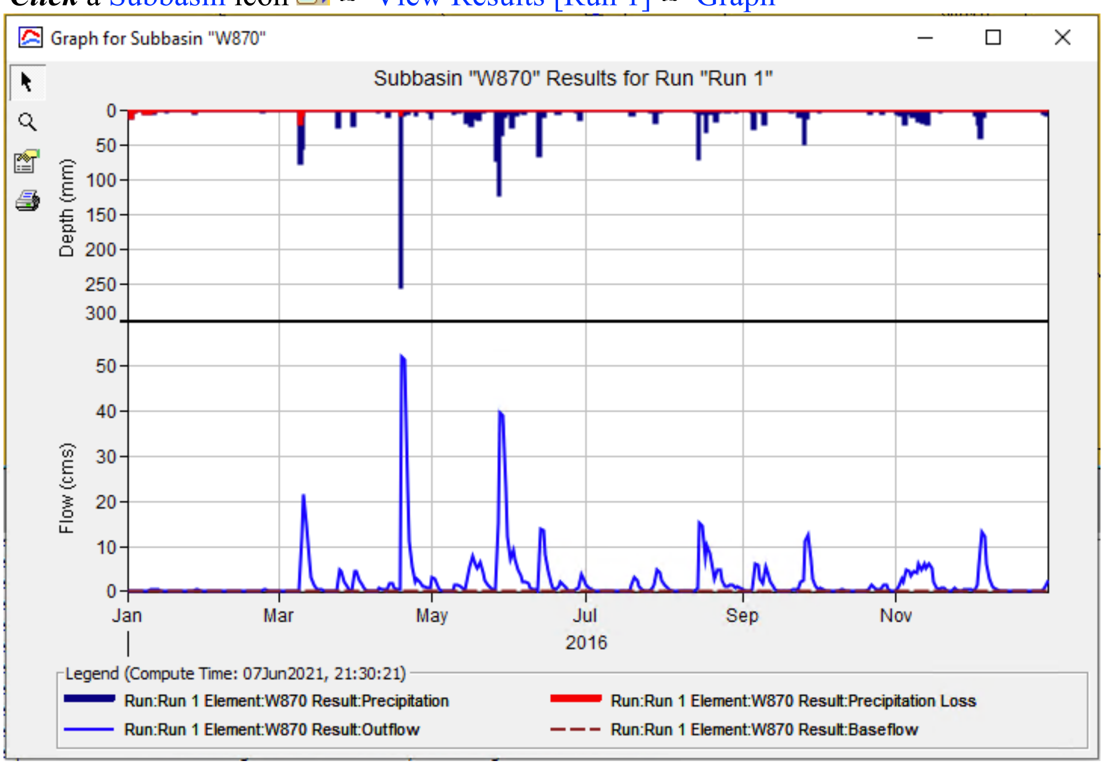
- ***Click*** Compute ☛ Create Compute Simulation ☛ Run…, in Create a Simulation Run [Step 1 of 4] window, ***Click*** Next. in Create a Simulation Run [Step 2 of 4] window, ***Click*** Next. in Create a Simulation Run [Step 3 of 4] window, ***Click*** Next. in Create a Simulation Run [Step 4 of 4] window, ***Click*** Finish.

- ***Click*** Compute ☛ Compute Run [Run 1]

5. Review results

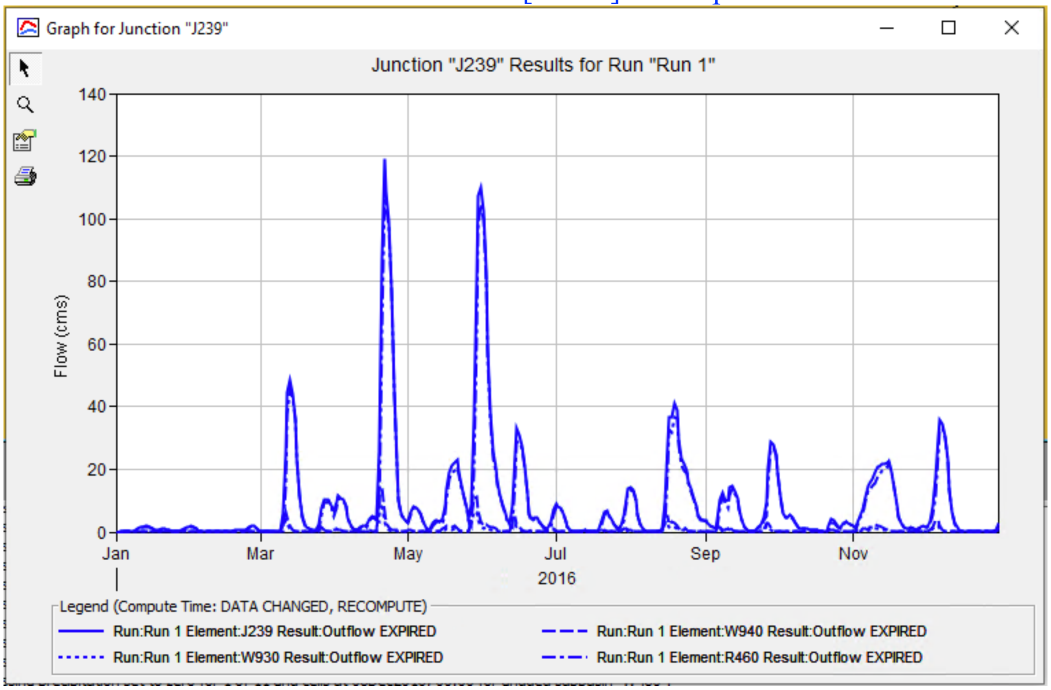
5.1 Subbasin Rainfall and Runoff

Right Click a Subbasin icon ☞ View Results [Run 1] ☞ Graph

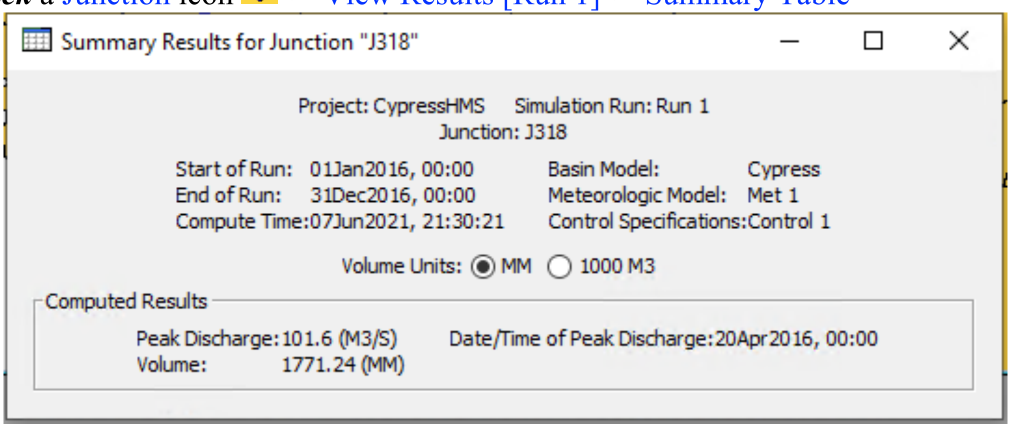


5.2 Junction

Right Click a Junction icon ☞ View Results [Run 1] ☞ Graph

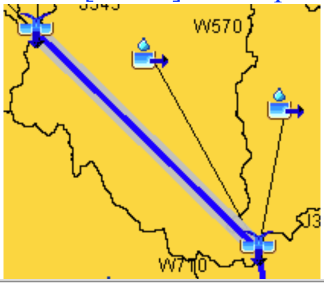


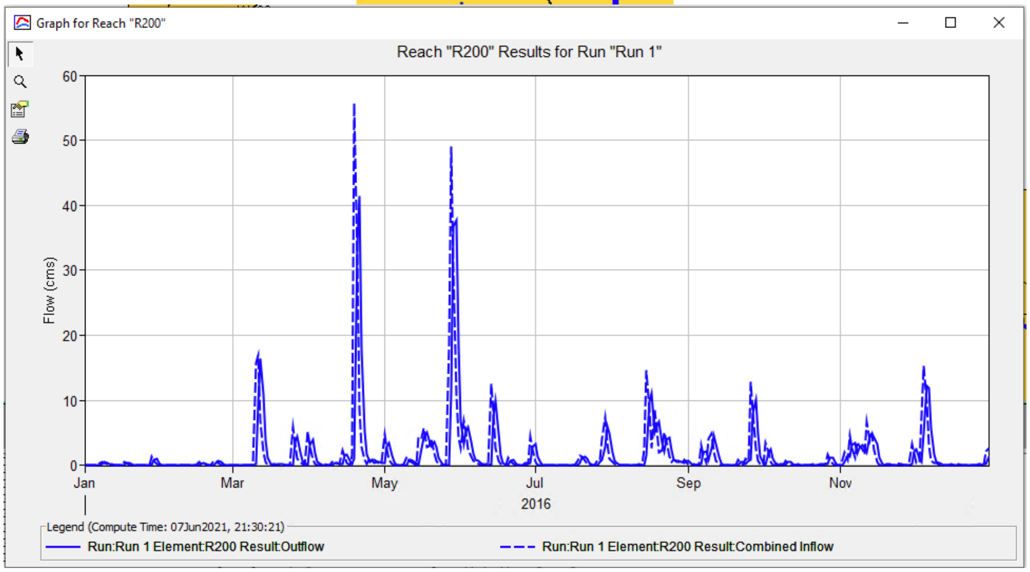
Right Click a Junction icon ☞ View Results [Run 1] ☞ Summary Table



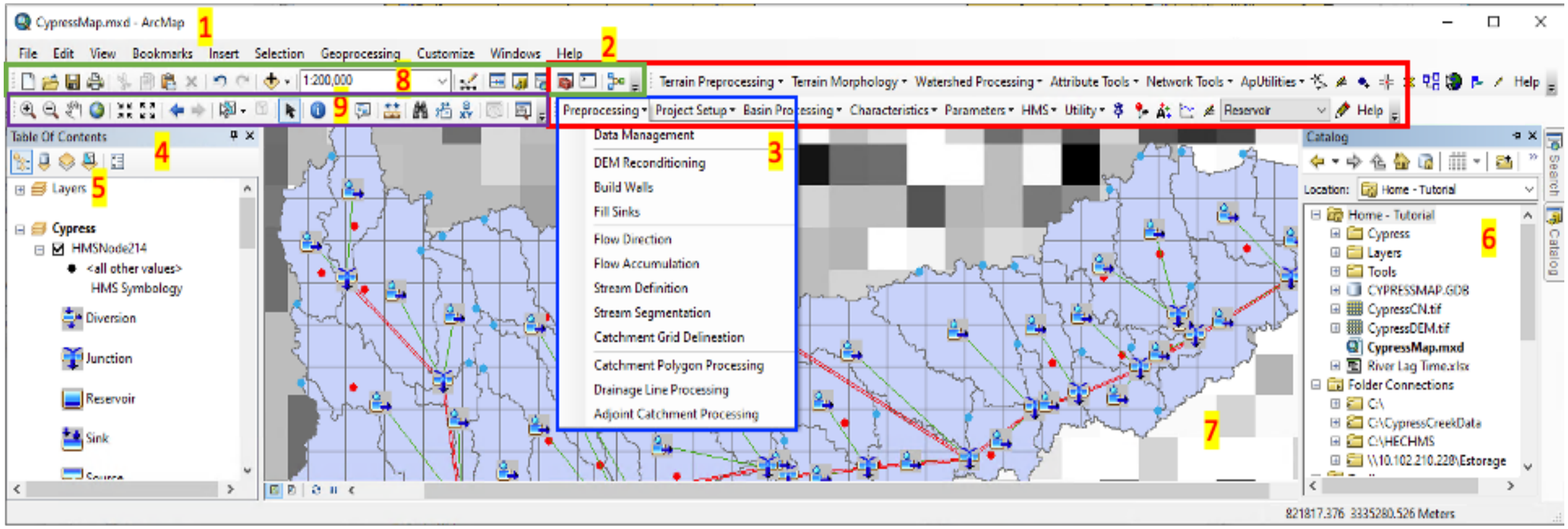
5.3 Reach

Right Click a Reach icon ☞ View Results [Run 1] ☞ Graph





Appendix 1 The introduction of the user interface of ArcMap



1. ArcMap Name: shows the map name that you are working on
2. ArcMap Menu
3. Arc Hydro and HEC-GeoHMS Menu, and Tools: contains the tools for geo-spatial analysis
4. Table of Content: store the different data frame
5. Data Frame: demonstrate the output file name and show the file in ArcMap Window <u>in sequence</u>
6. Catalog and Search: datasets and toolkits browser and search a toolkit
7. ArcMap Window: demonstrate the datasets
8. ArcMap Standard Menu
9. ArcMap Tools Menu

Appendix 2. The introduction of the user interface of HEC-HMS