Exercise 5. HEC-HMS Modeling using data from GIS Data Services Extension

GIS in Water Resources, Fall 2015

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Purpose

The purpose of this extension to exercise 5 is to develop and run your own HEC-HMS model for Onion Creek.

1. Preparation

This extension assumes you have already done Exercise 5 at

<u>http://www.caee.utexas.edu/prof/maidment/giswr2015/Ex5/Ex52015.pdf</u> and have an Ex5.mxd map document and Onion_HEC.gdb from having run AutoHMS -> GetData. Make sure that ArcMap has been saved, closed and re-opened before proceeding because the Run AutoHMS tool sometimes gives errors if this has not been done.

Onion_HEC.gdb is in <u>http://www.neng.usu.edu/cee/faculty/dtarb/giswr/2015/Ex5Data.zip</u> for students who are unable to use the ArcGIS services through an organizational account.

2. Prepare HEC-HMS basin file

Use this data downloaded in Exercise 5 in AutoHMS to create a .BASIN file, which is an ASCII text file used by HEC-HMS to populate the software with hydrologic elements and their respective attributes (i.e. downstream connectivity, loss parameters, routing parameters, basin area).

1) Open ArcMap and locate the Run AutoHMS tool in the AutoHMS Tool.tbx toolbox. This should be in Ex5tools in the project folder where you initially unzipped

http://www.neng.usu.edu/cee/faculty/dtarb/giswr/2015/Ex5tools.zip

2) Select the *Run AutoHMS* script from the toolbox.

AutoHMS Tool.tbx
 Get Data
 Run AutoHMS

- 3) Input the geodatabase created with the *Get Data* script (Onion+HEC.gdb).
- 4) Select an output directory where the HEC-HMS .BASIN file will be saved.
- 5) Input a name for the .BASIN file (i.e. *OnionCreek*).
- 6) Select *OK*. This process should take approximately 1 minute to complete.

S Run AutoHMS	
Input Geodatabase	Run AutoHMS
C:\giswr2015\Ex5\Onion_HEC.gdb	
Output Directory	Preprocessing tool for HEC-HMS model using NHDPlusV2.1 and
C:\giswr2015\Ex5\HEC	ArcGIS Living Atlas server data input.
Basin File Name	
OnionCreek	
-	-
OK Cancel Environments << Hide Help	Tool Help

Note that this function sometimes gives errors if the layers it is working on are open in ArcMap, so if you get an error, remove all layers from Onion_HEC.gdb from your map, save, close and reopen and try again.

You should now have much more data in Onion_HEC.gdb and the file OnionCreek.BASIN that specifies the basin model for HEC-HMS.



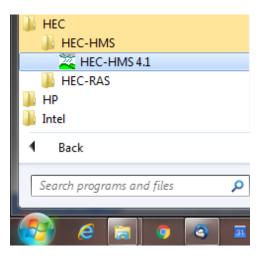
The basin file OnionCreek.BASIN is a text file that you can open in a text editor (e.g. Wordpad) to view the input properties computed from the GIS information. You should not edit information in this file unless you really know what you are doing.

Name	<u>^</u>	Date modified	Туре	Size
Onion	Creek.BASIN	10/26/2015 10:54	BASIN File	29 KB
	Last Modi Version 3 Filepath Unit Syst Missing F Enable Fl Allow Ble	fied Date: 26 Octo fied Time: 22:54:1 .5 Separator: \ em: English low To Zero: No ow Ratio: No	LG	
		diment Routing: No ality Routing: No		
	Canvas Y:	tion-J2 -167820.293892 -1141769.96992 m: Flowline-2		
	Canvas Y:	tion-J5 -159223.955437 -1145511.5417 m: Flowline-10		

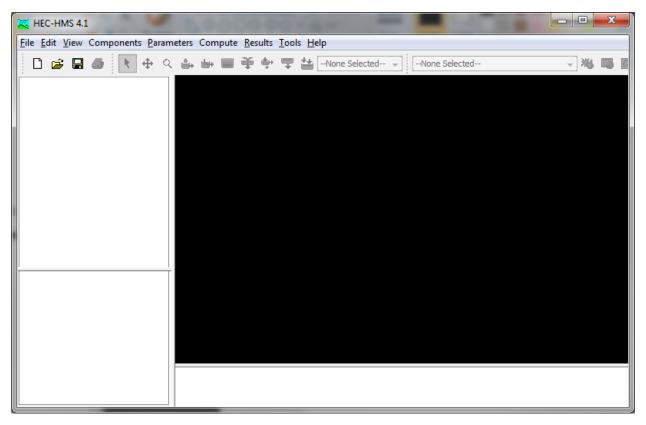
To turn in: Open the attribute table for the Subbasin feature class in Onion_HEC.gdb. For the largest subbasin (Note that Subbasin in HEC corresponds to Catchments we delineated earlier) report the slope and percentage imperviousness (Imp column). Compare these values to the values you calculated above using zonal statistics.

3. Prepare other inputs and run HEC-HMS

Start HEC-HMS from the start button or desktop icon.



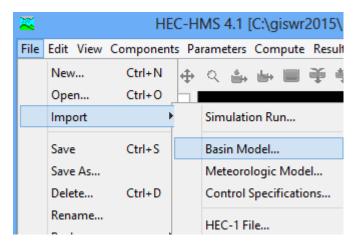
Initially you get this blank screen



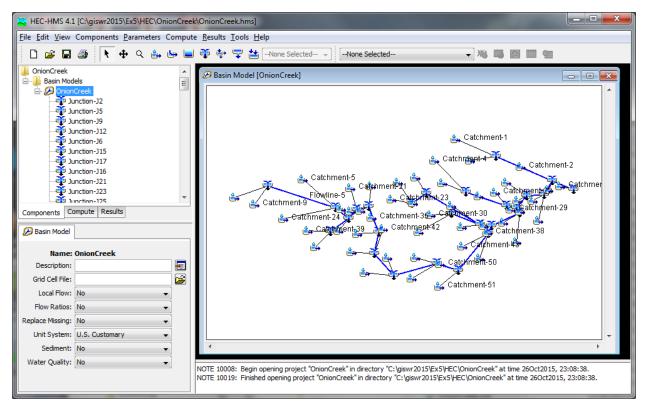
From the File menu (or icon) select New and set a name, location and U.S. Customary units and click Create.

🔀 Create a New Pro	ject 💽
Name:	OnionCreek
Description:	Onion Creek at Highway 183
Location:	C:\Users\dtarb\Ex5\HEC
Default Unit System:	U.S. Customary -
	Create Cancel

A new folder with the Name given will be created in the location you designate. Click File -> Import -> Basin Model and select the OnionCreek.BASIN file produced by ArcGIS.



In the components panel on the left you should see OnionCreek under Basin Models. Click on this to see the Basin Model window. Note that a Basin, in HEC Jargon has been created for each catchment in the Catchments polygon provided to the HEC-HMS data preparation scripts. This is a detailed distributed representation of the Onion Creek watershed that would have been tedious and error prone to set up by hand. Pretty cool!



Note that you may need to select View -> Maximum Extents and adjust the Element buffer to see the most downstream elements in the Basin Model View

🔏 Maximum Extents [Onion(Creek]
Method: Union Of All Elemen	
Manual view extents	
Minimum Northing:	-1163126.2456
Maximum Northing:	-1137418.0178
Minimum Easting:	-211199.1702
Maximum Easting:	-152207.1355
Set values from cu	rrent view: Set
Element buffer Perc <mark>nt (%)</mark> 15	
	OK Cancel

In addition to basin properties, HEC needs meteorological information to determine a design storm. The City of Austin provides precipitation depth-duration frequency information at

https://www.municode.com/library/tx/austin/codes/drainage_criteria_manual?nodeId=APXBDERAFRIN RAFRAUTRCOTE

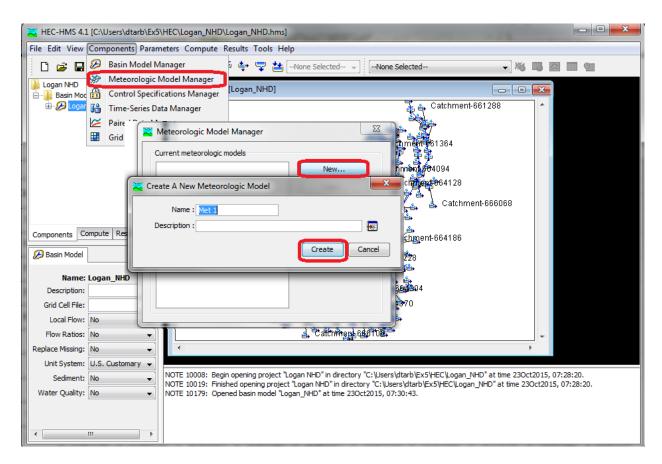
The values circled are for a 100 year storm

Table 1. Depth-duration frequency of precipitation for Austin and Travis County, Texas

[Note: Values in table derived from Asquith (1998). The location used to define the parameters of the precipitation distribution was Tom Miller Dam on the Colorado River near the center of the Austin area located at latitude 30°17'39" and longitude 97°47'12". min., minutes; hr, hours; in., inches]

Annual non-exceedance probability (percent)	Recurrence interval	Precipita	tion depth	n and dura	ation								
	(years)	15 min (in)	30 min (in)	1 hr (in)	2 hr (in)	<u>3</u> hr (in)	6 hr (in)	12 hr (in)	1 day (in)	2 day (in)	3 day (in)	5 day (in)	7 day (in)
0.500	2	0.98	1.32	1.72	2.16	2.32	2.67	3.06	3.44	3.81	4.04	4.30	4.57
.600	2.5	1.05	1.42	1.86	2.35	2.53	2.91	3.33	3.84	4.28	4.51	4.81	5.08
.700	3.33	1.14	1.54	2.04	2.58	2.79	3.19	3.64	4.33	4.84	5.08	5.43	5.70
.800	5	1.26	1.71	2.28	2.89	3.13	3.56	4.07	4.99	5.60	5.85	6.26	6.53
.900	10	1.47	1.98	2.68	3.42	3.71	4.21	4.81	6.10	6.88	7.14	7.65	7.91
.960	25	1.76	2.36	3.28	4.20	4.55	5.14	5.90	7.64	8.63	8.91	9.53	9.75
.980	50	2.01	2.68	3.79	4.88	5.28	5.94	6.86	8.87	10.0	10.3	11.0	11.2
.990	100	2.29	3.04	4.37	5.66	6.11	6.85	7.96	10.2	11.5	11.8	12.6	12.7
.996	250	2.73	3.57	5.26	6.86	7.38	8.24	9.67	12.0	13.6	13.9	14.7	14.8
.998	500	3.11	4.02	6.06	7.94	8.51	9.47	11.2	13.5	15.2	15.6	16.5	16.5
•					1	"							•

In HEC-HMS click on Components -> Meteorologic Model Manager and Click New. Accept the default name and click Create.



Close the Meteorologic Model Manager using the red X. Your components listing now includes a Meteorologic Model. Click on Met-1, and then in the panel for setting properties at the bottom left switch from a Specified Hyetograph to **Frequency Storm**.

🔀 HEC-HMS 4.1 [C	:\Users\dtarb\Ex5\HEC\Logan_N	IHD\Logan_NHD.hms]
File Edit View Co	mponents Parameters Compu	te Results Tools Help
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Logan NHD Logan Models Basin Models Meteorologic Meteorologic Meteorologic Meteorologic Speci		Basin Model [Logar
Components Comp		
Met Name:	Met 1	
Description:		
Shortwave:	None 👻	
Longwave:	None 🗸	
Precipitation:	Specified Hyetograph 🚽	
Evapotranspiration		•
Snowmelt:	Gage weights	
	Gridded Precipitation	NOTE 10008: Begin openir
	HMR.52 Storm Inverse Distance ≡	NOTE 10019: Finished ope
Replace Missing:	SCS Storm	07:28:20. NOTE 10179: Opened basi
	Specified Hyetograph	Thore 10179: Opened bas
	Standard Project Storm 🔹	
•	4	

Click Yes to the warning about losing data. We have not entered any data for a specific Hyetograph that we would be in danger of losing. Note that above the detail under the Met-1 Meteorology Model changes to Frequency Storm.

Click on Basins next to the Meteorology Model tab and under Include Subbasins, toggle from No to Yes.

Components Compute Results	
Met Name: Met 1	I
Basin Model Include Subbasins	I
OnionCreek No 🗸	
Yes No	

You should then see that in the table of components each catchment is listed below the Frequency storm indicating the association of the Frequency Storm with each Catchment.

Click on Frequency Storm so that its parameters are displayed in the bottom left panel. Change the settings indicated. Note that what is displayed in blue is unsaved. If you click save in the top bar the data will be saved to the project file and display switch to black. You should do this periodically.

OnionCreek Basin Models OnionCreek Meteorologic Meteorologic Cato Cato Cato Cato Cato Cato Cato Cato	eek Models uency S hment- hment- hment- hment- hment- hment-	Storm 10 11 12 13 14 15 16		4 III +		
Components Comp	oute R	Results		_		
Frequency Storm						
Met Name:	Met 1					
Probability:	Other			-		
Input Type:	Partial	Duration		-		
Output Type:	Annua	Duration				
Intensity Duration:	15 Min	utes		-		
Storm Duration:	6 Hour	s		- 1		
Intensity Position:	50 Per	cent		-		
Storm Area (MI2)	*					
Curve:	Unifor	m For All Sub	basins	-		
Duration		Partial-Dura	ation Depth	(]		
5 Minutes			-			
15 Minutes			2	2.29		
1 Hour			4	1.37		
2 Hours			5	5.66		
3 Hours			e	5.11		
6 Hours			e	5.85		
12 Hours			-			
1 Day						

Next click Components -> Control Specifications Manager and New and Create, leaving the default name Control-1.

KING HEC-HMS 4.1 [C:\Users\dtarb\Ex5\HE	C\Logan_NHD\Logan_NHD.hms]	- • ×
File Edit View Components Parameter	rs Compute Results Tools Help	
🗋 🖆 🔚 🥔 Basin Model Mana		•
Logan NHD Basin Moc Scottrol Specificat	ions Manager 🖁 Basin Model [Logan_NHD] 💿 🔳 📧	
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Grid Data Manage		
Catchment-661288	Copy	
E Catchment-661292 Catchment-661296	Create A New Control Specifications	
	Name : Control 1	
Components Compute Results	Description : Fe 564186	
Frequency Storm	Create Cancel	
Met Name: Met 1		
Probability: Other	304	
Input Type: Partial Duration		
Output Type: Annual Duration		
Intensity Duration: 15 Minutes	▼	
Storm Duration: 12 Hours	•	
Intensity Position: 50 Percent		
Storm Area (MI2)	NOTE 10008: Beain opening project "Logan NHD" in directory "C:\Users\dtarb\Ex5\HEC\Logan NHD" at time	230ct2015, 07:58:23.

In the components panel on the left collapse Meteorologic models and expand Control Specifications and click on Control-1. Set start and end date and times as indicated. These are arbitrary. We are looking for 2 days of simulation and a 6 hour storm.

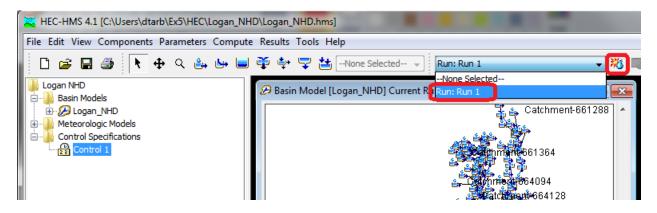
Logan NHD Basin Models Cogan_NHD Meteorologic Models Control Spectfications Control 1	
Components Compute Results	
Control Specifications	
Name: Control 1 Description:	E
*Start Date (ddMMMYYYY) 23Oct2015	
*Start Time (HH:mm) 1:00	
*End Date (ddMMMYYYY) 25Oct2015	
*End Time (HH:mm 1:00	
Time Interval: 15 Minutes	-

Now we are ready to set up a model run. Click Compute -> Simulation Run Manager and select New

Kerner Hec-HMS 4.1 [C:\Users\dtarb\Ex5\HEC\L	ogan_NHD\Logan_NHD.hms]	-
File Edit View Components Parameters	Compute Results Tools Help	
🗋 🚅 🖬 🎒 💽 🕂 🤹	Create Compute	- ** =
Logan NHD Basin Models Logan_NHD Meteorologic Models Control Specifications Control 1	 Forecast Alternative Manager Depth-Area Analysis Manager Uncertainty Simulation Run Manager Multiple Cc Check Para Compute 	nment-661288
Components Compute Results Components Compute Results Control Specifications Name: Control 1 Description: *Start Date (ddMMMYYYY) 23Oct2015 *Start Time (HH:mm) 1:00 *End Date (ddMMMYYYY) 25Oct2015	Rename Delete Edit View Messages	

Accept the default name Run 1 and click Next. At step 2, accept the single choice of OnionCreek as the Basin Model and click Next. At step 3, accept Met 1 as the single choice of Meteorologic Model and click Next. At step 4, accept Control 1 as the single choice of Control Specifications and click Finish. Close the Simulation Run Manager.

On the top menu bar select Run 1.

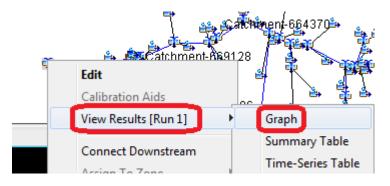


The model should now be ready to run with the "Compute Current Run" button activated

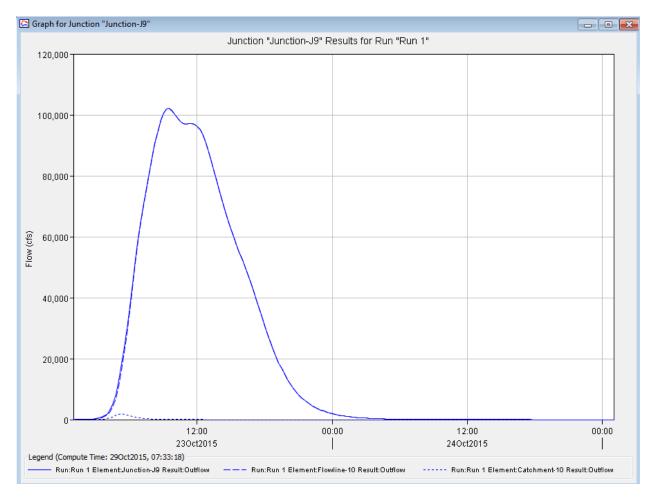


Click this button. The model should now run. You will see a number of warnings and a progress bar. You can ignore the warnings for this exercise (though if doing this professionally you should check each).

You can right click on elements in the Basin Model window to view results at that location in Graph or Table form.



Here is the graph of flow at the outlet.

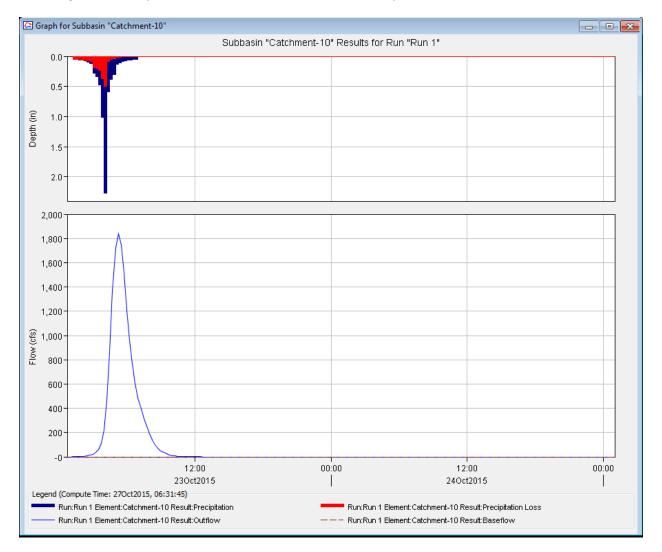


Note a flow just over 100,000 cfs. Do you think this is realistic?

Go to the USGS NWIS site for this watershed

<u>http://waterdata.usgs.gov/nwis/inventory/?site_no=08159000</u> and check peak streamflow at this location.

If you click on the results for the subbasins, you can see the storm being applied to each. This is plotted top down. The storm lasts for 6 hours but has a peak near the center that reflects high intensities following the intensity-duration data that we inserted from City of Austin website.



Note that when displaying a time series table you can select the data and right click to export to a text file.

		Project: Logar Junction	NHD Simulation Junction-J80000	Run: Run 1 1004.0	
End o	fRun: 2	23Oct2015, 01 25Oct2015, 01 23Oct2015, 08	L:00 Meteo	Vodel: Logan_NHD rologic Model: Met 1 nent-5 I Specifications:Control 1 catchment-4	
Date	Time	Inflow from (CFS)	Outflow (CFS)	ent-6	
23Oct2015	01:00	0.0	0.0		
23Oct2015	01:15	1.0	1.0	ent-8	
23Oct2015	01:30	2.4	24	ent-8	
23Oct2015	01:45		Cut		
23Oct2015	02:00		Сору	hment-10	
23Oct2015	02:15				
23Oct2015	02:30		Paste		
23Oct2015	02:45		Incent Devu(a)		
23Oct2015	03:00	:	Insert Row(s)	atchment-15	
23Oct2015	03:15		Delete Row(s)		
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23Oct2015	03:45			🔀 Table Export Options 🧧	x
23Oct2015	04:00		Clear		
23Oct2015	04:15		Fill	▼ Include column labels	
23Oct2015	04:30				
23Oct2015	04:45		Export	Project directory: C:\Users\dtarb\Ex5\HEC\Output.txt	Ē
23Oct2015	05:00	0.60		OK Cance	
23Oct2015	05:15	69.1	69.1		
23Oct2015	05:30	80.8	80.8		_

This is a convenient way to export the data to Excel for making comparative plots.

Prepare graphs where you show HEC-HMS hydrographs at the outlet and at an illustrative locations about 1/2 of the way up Onion Creek from the outlet to the source. Prepare a map where you indicate the locations where you have done these comparisons. These should show how the peak of the hydrograph increases as one moves downstream and the basin area gets larger.

To turn in: Prepare a short report where you give the Hydrograph from HMS at the outlet and one other location (about half way up from the outlet). Include a layout where you show these locations. Interpret the graphs/results that you present. Include in your report at least one catchment where you show the precipitation, precipitation loss and runoff.

OK. You are done!

Summary of Items to turn in.

1. Open the attribute table for the Subbasin feature class in Onion_HEC.gdb. For the largest subbasin (Note that Subbasin in HEC corresponds to Catchments we delineated earlier) report the slope and percentage imperviousness (Imp column). Compare these values to the values you calculated above using zonal statistics.

 Prepare a short report where you give the Hydrograph from HMS at the outlet and one other location (about half way up from the outlet). Include a layout where you show these locations. Interpret the graphs/results that you present. Include in your report at least one catchment where you show the precipitation, precipitation loss and runoff.