

# HEC-HMS Lab 3 – Using Thiessen Polygon and Inverse Distance Weighting

Created by Venkatesh Merwade ([vmerwade@purdue.edu](mailto:vmerwade@purdue.edu))

---

## Learning outcomes

The objective of this lab is to learn how to input data from multiple rainfall gages into HEC-HMS and evaluate the role of gage locations and their corresponding weights on the streamflow hydrograph. By the end of this exercise, you will:

- 1) Know how to feed data from multiple rainfall gages into HEC-HMS
- 2) Know how to enter the weight for each rainfall gage when using multiple gages
- 3) Know how to use Thiessen polygon and IDW in HEC-HMS
- 4) Understand the role of spatial rainfall dynamics on streamflow hydrograph

**Student Time Required:** 90 minutes

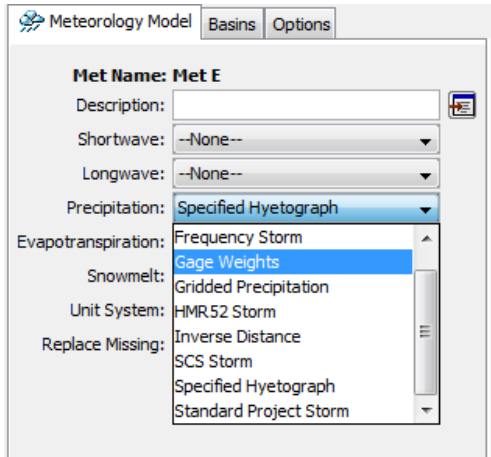
## Instructions

Create a new folder called Thiessen. Save your project from lab1 as (use Save As in the File menu) Thiessen.hms in this new folder. If you have more than three precipitation gages in your lab 1, keep only the first three, and delete other gages. Make sure your gages has the following three events (Date and time must match for all three gauges):

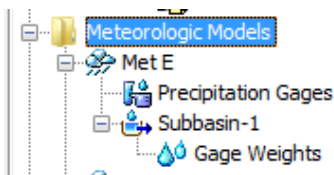
Gage 1		Gage 2		Gage 3	
Time	P (mm)	Time	P (mm)	Time	P (mm)
9:00	0.00	9:00	0.00	9:00	0.00
10:00	5.08	10:00	2.00	10:00	1.50
11:00	10.16	11:00	3.08	11:00	2.50
12:00	2.54	12:00	5.16	12:00	3.54
13:00	2.00	13:00	5.00	13:00	4.00
14:00	1.00	14:00	2.54	14:00	4.16
15:00	0.00	15:00	2.00	15:00	3.08
16:00	0.00	16:00	1.00	16:00	2.00

## Using Gage Weights in HEC-HMS

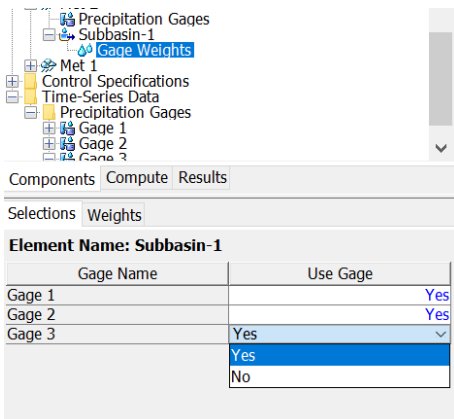
Create a new Meteorology File/Model called “Met E”(E for equal weights). For this file, change the precipitation type from Specified Hyetograph to Gage Weights as shown below. Make sure you change the Replace Missing option to “set to Default”



In the Basins tab next to the Meteorology Model, make sure you select Yes to include sub-basins. Once this is done, Sub-basin 1 will also appear under Meteorologic Models as shown below:



Expand sub-basin 1, and you will then see Gage Weights. Select Gage Weights. In the Selections tab in component editor, you will select the first three gages for sub-basin 1 as shown below. Make sure the use gage option is set to "Yes" for all gages.



Next, you will assign weights by using the Weights tab in the component editor. Use equal weights for the first run, and enter 1 for all depth weights and time weights. When you use time series gages to specify rainfall hyetographs, the numbers in the time weight column represent the weights that will be used in interpolation. When daily rainfall values are used, the numbers in the depth weight column will be used in interpolation.

Selections		Weights	
<b>Element Name: Subbasin-1</b>			
Gage Name	Depth Weight	Time Weight	
Gage 1	1	1	
Gage 2	1	1	
Gage 3	1	1	

Now create a new simulation called Equal\_weights, and run the simulation. Make sure your data and the start time in the control specification file matches with rainfall data. Also run the model long enough to get a complete hydrograph. Use a time interval of 10 mins for your simulation.

Using the data from the time-series table of the output, create a presentation quality hydrograph (plot of total flow versus time) in Excel. Report the peak flow, the timing of the peak flow, total input (in mm), loss (in mm) and total output (in mm).

### Assigning Weights Using Thiessen Polygon

Assume the sub-basin to be 10km x 10 km square area. The coordinates for the three gages used earlier are: G1 (1,5), G2 (8.5, 8.5) and G3 (5.5,1.5). Using (0,0) as the origin (lower left corner of the watershed), compute the Thiessen weight for each gage using an engineering sheet (provided). Create a new Meteorologic Model (Met T), again use the gage weights option and assign the Thiessen weight for each gage that you found. Use the same numbers for both Depth and Time weight columns. Create a new simulation (called Thiessen 1) using Basin 1, Met T and Control 1, and run the Thiessen\_weight simulation.

Next, create a new Meteorologic Model (Met T2), again use the gage weights option and assign the Thiessen weight as 0.6, 0.1 and 0.3 for gage 1, 2, and 3 respectively. Create a new simulation (Thiessen 2) and get a new hydrograph in Excel. Report the peak flow, the timing of the peak flow, total input (in mm) and total output (in mm).

Repeat this process one more time with 0.2, 0.3 and 0.5, for gage 1,2, and 3, respectively. You will create a new Meteorologic model (Met T3), new simulation (Thiessen 3) and a new hydrograph in Excel. Report the peak flow, the timing of the peak flow, total input (in mm) and total output (in mm).

### Turn-in (Part A)

The hydrographs from the equal weights and the three Thiessen weight hydrographs. Also include peak flow, the timing of the peak flow, total input (in mm) and total output (in mm) for all hydrographs. **Write a paragraph (at least 50 words)** about the differences you see in these hydrographs and the reasons for these differences.

### Use of IDW in HEC-HMS

In using Thiessen polygon approach with HEC-HMS, you had to compute and assign these weights to each gage. This has to do with how HEC-HMS uses basin information because it does not get the exact shape of the watershed boundary from the user to compute the areas of Thiessen polygons so we had

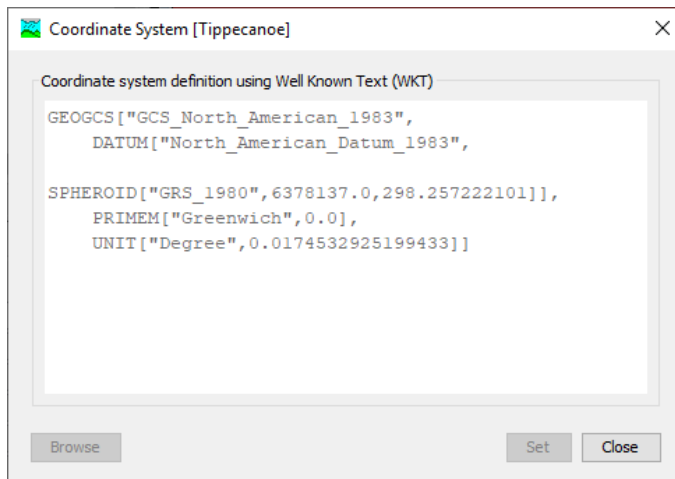
to provide these weights. In the case of IDW, the weights are based on distances so it is possible to compute IDW weights in HEC-HMS if we provide the exact georeferenced position of the gages. In this part of the exercise, we will learn how to geo-reference a sub-basin and all the gages for using the IDW method of rainfall interpolation. Download Tippecanoe.zip from blackboard. It is under Lab03 folder. The file is also available at this link: <http://web.ics.purdue.edu/~vmerwade/education/tippecanoe.zip>

Unzip Tippecanoe.zip. It is a GIS Shapefile of the Tippecanoe County.

We will work in the same HMS project where you use the Thiessen weights for the rainfall data.

Create a new basin model and name it as Tippecanoe. Give appropriate description for the basin.

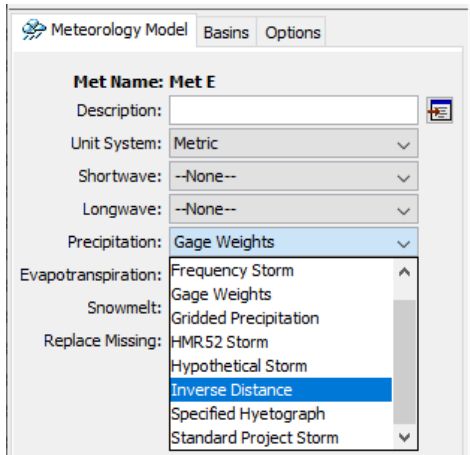
Go to View→Map Layers, and browse to the tippecanone.shp (boundary of Tippecanoe County). Once the boundary is added, you will see that the desktop in HEC-HMS is now showing the Tippecanoe county boundary. Next, go to GIS→Coordinate System. Use the Browse button to import coordinates from tippecanoe.prj (same location where you have the shapefile).



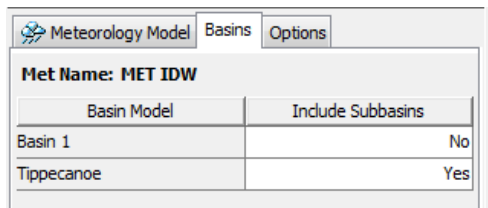
Now, create a sub-basin approximately at the Centroid of Tippecanoe County. Now that we have coordinates defined for this area, you will see the lat/long information when you move your cursor over the Tippecanoe boundary. Use your judgment to create the sub-basin at the center of the Tippecanoe county.

Use the same loss and transform method as used in Lab 1 including the area of 100 km<sup>2</sup>. The parameter values for both loss and transform methods also identical to what you used in Lab 1. If you do not have lab 1, you can see this information in Basin 1 in the same HEC-HMS project.

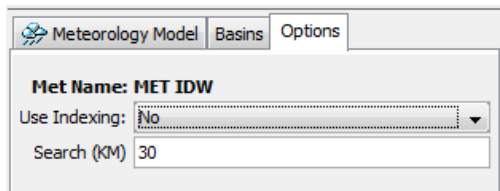
Once you have populated the basin model with appropriate methods and parameters, create a new Meteorologic model (Met IDW). In the new meteorologic file, change the precipitation to Inverse Distance as shown below.



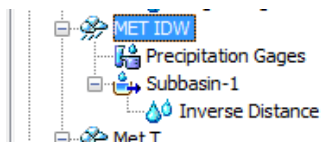
Similarly go to the Basins tab and add Tippecanoe sub-basin to Met IDW as shown below. We do not want Basin 1 associated with this Met model.



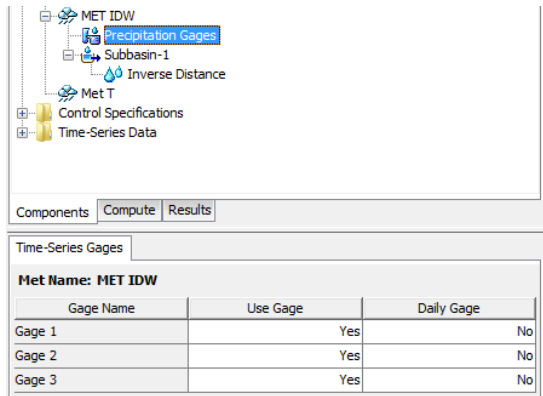
Go to options tab, and change the search distance to 30 KM. This will tell the program to only include gages that are within this radius while computing the weights.



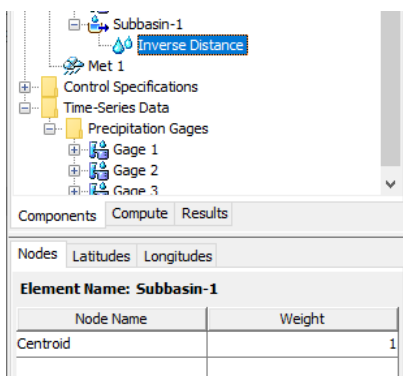
Next, you will see that Inverse Distance is added sub-basin 1 of Tippecanoe basin in the MET IDW file as shown below:



Select Precipitation Gages and link all gages to this Meteorologic file as shown below (leave Daily Gage as “No”):



Click on Inverse Distance, and give a name and weight to the node in the component editor as shown below. This node is basically the point for which the data will be interpolated from all the gages. The weight column dictates how the interpolated data will be applied to the sub-basin. Use as weight of “1”, which means the interpolated hydrograph will be applied without modification. Note that we are using centroid as a reference point to get the distance weighted average of all gauges within the Tippecanoe boundary. The weighed rainfall calculated at this centroidal point will then be applied to the entire sub-basin.



Input the latitude and longitude for this point as: (40°24'58", -86°54'4"). Similarly, enter the following lat/long for all three gages by going to Time Series folder: Gage 1 (40°24'18", -87°2'10"); Gage 2 (40°29'50", -86°48'7"); Gage 3 (40°17'42", -86°52'55"). When you enter latitude and longitude information for each gage, the distances will be computed by HEC-HMS to get the weights for each gage for use in the IDW method.

Now, create a new simulation run (IDW), and run the model.

### Turn-in (Part B)

1. IDW hydrograph.
2. Report the peak flow, the timing of the peak flow, total input (in mm) and total output (in mm).
3. Write few lines about the differences you see in IDW hydrograph compared to the hydrographs that you obtained from Thiessen weights. Is the IDW hydrograph closer to any of the earlier hydrographs? Why?

**Both Part A and Part B of this lab are due on February 14 by 1:30 PM. Please do not print anything when the lab is in session.**