Problem: *Flood Frequency Estimates for a Watershed*

Statement:

For your chosen watershed (from the Project #1 assignment), use annual maximum peak discharge data to examine the flood characteristics of the watershed.

As part of this exercise, you will need to get peak streamflow data from the USGS and run the USGS flood frequency analysis program PeakFQ. You can download the program from:

https://water.usgs.gov/software/PeakFQ/

PeakFQ implements the standard method for flood frequency analysis, as outlined in Bulletin 17B. There is a nice Youtube video showing everything you need to know to use the program:

PeakFQ (Version 7.1) Flood-Frequency Analysis Demo https://www.youtube.com/watch?v=w-j2S3APUgk

Do the following steps in your analysis:

a. For your chosen watershed, go to its site on USGS NWIS. Get a copy of the peak streamflow *Graph* and the peak streamflow data in two different formats. Include the graph in the Solution for part a). Floo

   Note: You have been to the USGS NWIS site before for your watershed in the Project #1 assignment. If you know the USGS stream-gage number, you can go to the site quickly from the NWIS mapper by entering the number in the *Site Number(s)* search area. Click on the icon and select *Access Data*. From the list of Available Data, select the *Peak Streamflow* link. Download the Graph by selecting the *Download a presentation-quality graph* link. Return and select *Tab-separated file* to load the peak streamflow data, and then right-click to save the data as a text file. Finally, return and select *peakfq (watstore) format* to load the data, and then right-click to save the data as a text file (pick a different name – **do not** overwrite the first text file).

   FYI: The data in the graph and the files show the largest recorded peak streamflow for each water year (from October 1 to September 30). These data sometimes also contain historic peak streamflow (observations made when the stream-gage was not operational) for large events.

b. Create a graph showing the flood climatology. Plot the peak streamflow (in cfs) for all peaks that exceed the mean annual flood (MAF) versus the calendar day of the peak (Mon/Day). Exclude any historic peak streamflows (e.g., as these observations were made outside of the systematic stream-gage record).

Note: Use the *Tab-separated file* with Excel for your analysis. Start Excel and then open the text file. From the Text Import Wizard choose *Delimited* and then *Next* >. For Delimiters, choose *Tab* (no others) and then *Finish*. The data will be imported into Excel. Examine the **Peak Discharge-Qualification code** column (peak_cd); any peaks with the 7 code (Discharge is an HistoPEakric Peak) should not be used.

At this point, I recommend that you copy the **Date of peak streamflow** column (peak_dt) and the **Annual peak streamflow value in cfs** column (peak_va) for all remaining peaks to a new Excel sheet. Then, sort the date/peak data by peak streamflow (from largest to smallest peak).

The annual peak streamflow data contains the peaks for flood events, but many years the peak streamflow is not large enough to cause a flood. Often, the mean annual flood (MAF) is used as a rough threshold to define a "flood" event. We will use this threshold and will only plot peaks that equals or exceeds the MAF. Use Excel with the remaining peaks and compute the MAF.

For all the flood peaks (those that equal or exceed the MAF), plot the peak versus calendar date. Here is how I would do that. First, I recode the peak dates so that they all fall in the same calendar year (e.g., 2018). If the peak date appears in Excel cell `A1`, then the formula `=DATE(2018,MONTH(A1),DAY(A1))` would recode the date to 2018. I would create a new column for the recoded date and another column for the flood peaks (those exceeding the threshold) and then I would make my plot.

In your Solution for part b), include the graph. Also report on the calculated mean annual flood (in cfs), the number of peaks that equal or exceed this threshold (e.g., the number of floods shown in your graph), and the total number of peak in the record (excluding historic peaks).

c. Use the USGS PeakFQ program to do a flood frequency analysis. Include a graph showing the output from PeakFQ (flood data, flood frequency curve, and confidence intervals). Report the results for the 2-, 10-, and 100-year peak discharge using the Bulletin 17B estimates.

   Note: You will need to download and install the PeakFQ (sorry, there is only a Windows version). I recommend that you view the Youtube example and follow the steps. Read in the data and use its defaults for your analysis. The video shows how to make the graph to include. You will also need to *View* the Output File from the Results tab to get the peak discharge estimate for different return periods (which you can compute from the Annual Exceedance Probabilities shown in the output).

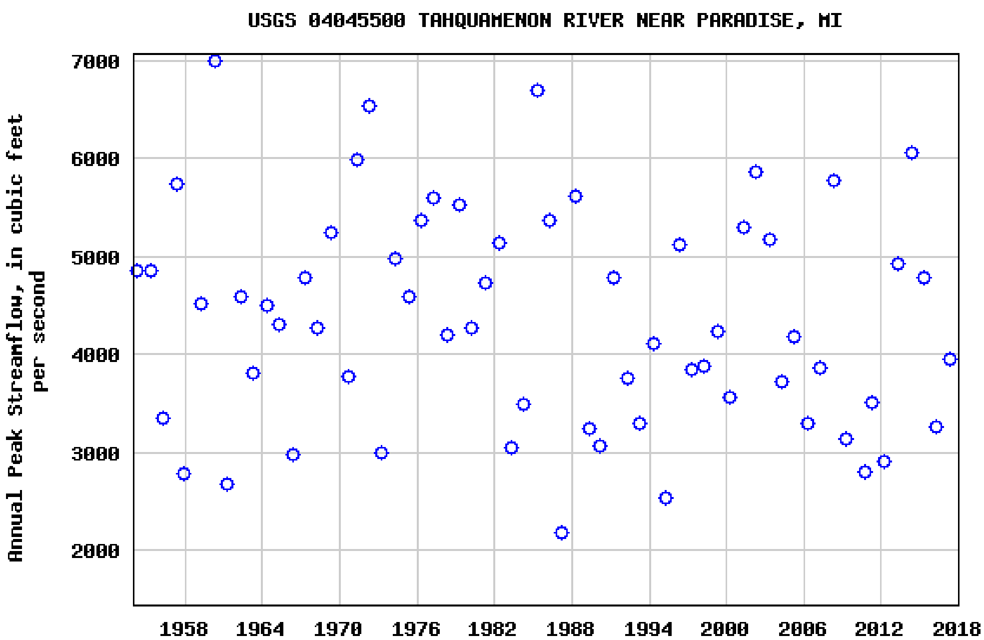
Solution:

Project-03

February 6, 2019

1 Flood Frequency Estimates for Watershed

A) See the graph below from USGS 04045500 TAHQUAMENON RIVER NEAR PARADISE, MI for peak annual streamflow

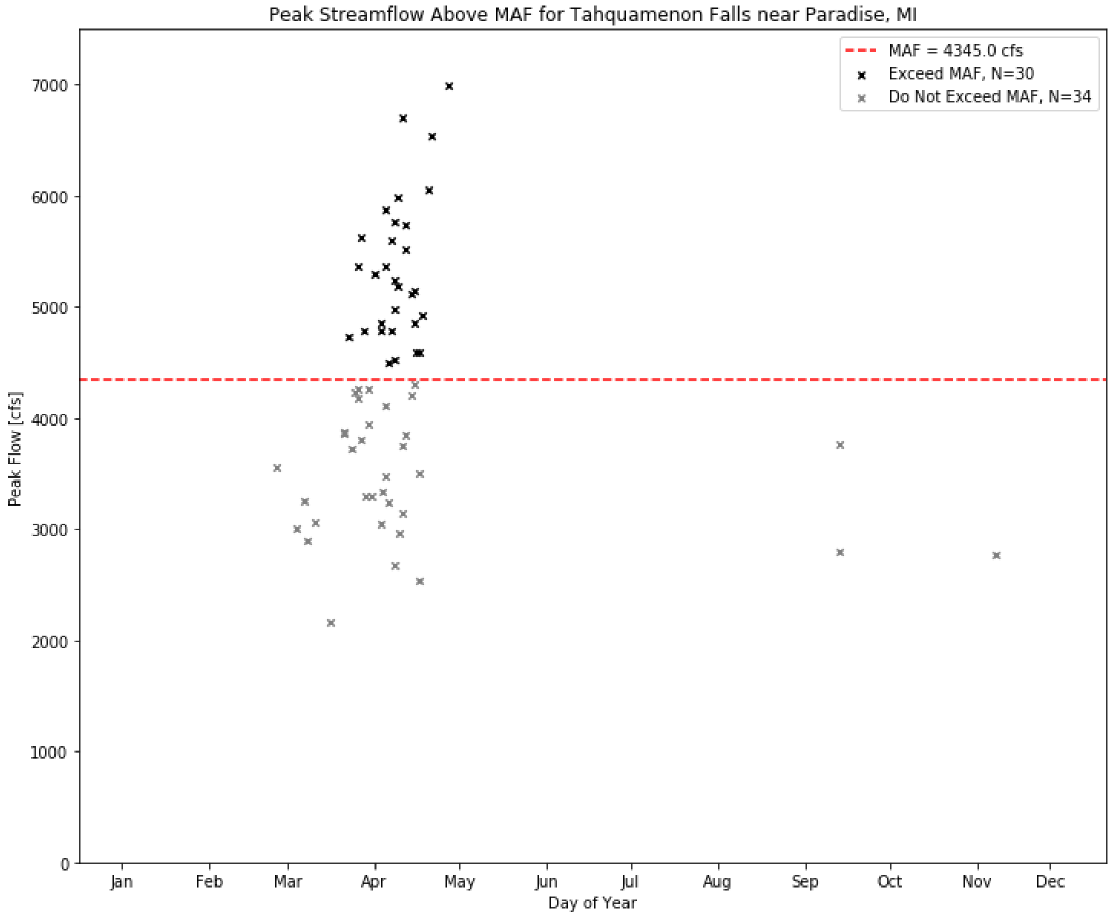


B)Create a graph showing the flood climatology. Plot the streamflow (in cfs) for all peaks that exceed the mean annual flood (MAF) versus the calendar day of the peak (Month/Day). Exclude any historic peak streamflows.

```
In [131]: data = pd.read_csv(
              'AnnualPeaks_Tahquamenon.txt',
              sep = '\t',
              skiprows = 69
          )

          data = pd.concat([data['10d'],data['8s'],data['8s.1']],axis=1)
          data.columns = ['Date',"Peak Flow [cfs]","Stage Height [ft]"]

          # Manipulate Data to prepare plot
```

```python
data.Date = pd.to_datetime(data.Date)
data['DayOfYear'] = data['Date'].dt.dayofyear
data = data.set_index(['Date'])

# No historic peaks, all modern
modern = data

# Calculate Mean Annual Flood
MAF = modern['Peak Flow [cfs]'].mean()
print("Mean Annual Flood: " + str(MAF.round()) + " cfs \n")

# Slice for above MAF
FloodExceed = modern[modern['Peak Flow [cfs]'] >= MAF]
NotExceed = modern[modern['Peak Flow [cfs]'] < MAF]

# Scatter Plot by day of year
fig,ax = plt.subplots(figsize=(12,10))
FloodExceed.reset_index().plot.scatter(x='DayOfYear',y='Peak Flow [cfs]',ax=ax,color='
NotExceed.reset_index().plot.scatter(x='DayOfYear',y='Peak Flow [cfs]',ax=ax,color='gr

ax.set_xlabel('Day of Year')
ax.set_xlim([0,365])
ax.set_ylim([0,7500])
ax.axhline(y=MAF,linestyle='--',color='r')

labels = ['Jan','Feb','Mar','Apr','May','Jun','Jul','Aug','Sep','Oct','Nov','Dec']
ticks = [15,46,74,105,135,166,196,227,258,288,319,345]
plt.xticks(ticks,labels)

plt.legend(
    [
        'MAF = {0} cfs'.format(MAF.round()),
        'Exceed MAF, N={0}'.format(len(FloodExceed)),
        'Do Not Exceed MAF, N={0}'.format(len(NotExceed))
    ]
)
plt.title('Peak Streamflow Above MAF for Tahquamenon Falls near Paradise, MI')

plt.savefig('MAF.png')
plt.show()
```

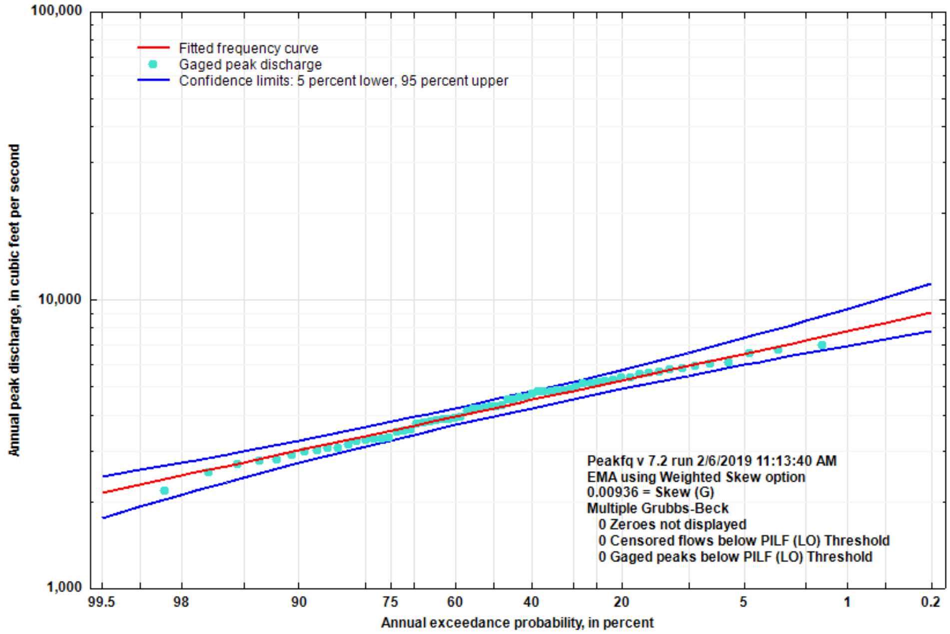
```
Mean Annual Flood: 4345.0 cfs
```



C) Use the USGS PeakFQ program to do a flood frequency analysis. Include a graph showing the output from PeakFQ. Report results for 2-, 10-, and 100- year peak discharge using the 17B estimates.

Per this publication, https://pubs.er.usgs.gov/publication/wri834194, the Upper Peninsula has a skew of 0.12 and the mean-square error associated with generalized skew on the basis of designated regions is 0.2. Using these values PeakFQ was run with the watstore data.

Occurence Interval, Years	Occurrence Probability	Flow [cfs]
2	0.5	4,201
10	0.1	5,894
100	0.01	7,776



100,000
10,000
1,000
Annual peak discharge, in cubic feet per second
Fitted frequency curve
Gaged peak discharge
Confidence limits: 5 percent lower, 95 percent upper
Peakfq v 7.2 run 2/6/2019 11:13:40 AM
EMA using Weighted Skew option
0.00936 = Skew (G)
Multiple Grubbs-Beck
0 Zeroes not displayed
0 Censored flows below PILF (LO) Threshold
0 Gaged peaks below PILF (LO) Threshold
99.5
98
90
75
60
40
20
5
1
0.2
Annual exceedance probability, in percent