Analysis Techniques: Flood Analysis Tutorial with Daily Data (Log-Perason Type III Distribution)

Information to get started:

- The lesson below contains step-by-step instructions and "snapshots" of what each step looks like when carried out in a Microsoft Excel workbook. Blue shading of information in the Excel illustrations denotes changes made from the previous step. Dots placed in three consecutive rows indicate that a portion of data is hidden from sight.
- You can download an Excel workbook containing the complete data set by clicking on the "Download Data" link below. It contains each calculation step on a separate worksheet. To move between steps, click on the tabs at the bottom of the excel window.
- When you download the file, it may open in your browser window. You may wish to use the "save as" function to save the file to a local drive and then reopen it in Excel. This will make it easier to flip between the online lesson and the example workbook.
- Finally, we want to remind you that the techniques explained on this site are statistically based; therefore results must be viewed as predictions and not as facts. Please use the techniques and the information obtained from them responsibly!

Download Data

Step 1: Obtain streamflow data

- Obtain daily streamflow data from the USGS web site.
 - o Go to http://oregon.usgs.gov
 - o Select Historical Water Data
 - o Select Surface Water
 - o Select Daily Data
 - o Check box under Site Identifier for Site Name and Submit
 - o Type in Alsea under Site Name and select match any part and Submit
 - o Select gage at TIDEWATER (140306500)
 - o Select Tab-separated data
 - For the tutorial, copy the data for water years 1990 through 2000 into an Excel worksheet
 - o Paste special as text (this will separate the data into columns
- Calculate the maximum discharge for each water year in the period of record.
- The AVERAGE, MAX, and MIN functions in excel can be used to calculate these values for each water year. It may be more efficient to calculate the mean, maximum, and minimum flows for each water year in the period of record at one time.

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A	6	B	C	D	Ε	F	G	
AGE	NCY	STATION	DATE (Month, Day, Year)	STREAMFLOW (CFS)	ANNUAL AVERAGES (CFS)	ANNUAL MAX (CFS)	ANNUAL MIN (CFS)	
USC	GS	14306500	10/1/90	63			PER CERTICION DE COMP	
USC	35	14306500	10/2/90	85				
USC	3S	14306500	10/3/90	93				
USC	35	14306500	10/4/90	96				
USC	3S	14306500	10/5/90	101				
USC	35	14306500	10/6/90	106				
USC	38	14306500	10/7/90	94				
USC	SS	14306500	10/6/90	87				
USK	38	14306500	10/9/90	84				
USC	GS	14306500	10/10/90	82				
USC	35	14306500	10/11/90	83				
USC	SS	14306500	10/12/90	94				
USC	35	14306500	10/13/90	99				
USC	GS	14306500	10/14/90	97				
USC	35	14306500	10/15/90	130				
USC	3S	14306500	10/16/90	177				
USC	35	14306500	10/17/90	152				
USC	38	14306500	10/18/90	241				
USC	GS	14306500	10/19/90	350				
USC	35	14306500	10/20/90	209				
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US	S	14306500	9/30/00	66	1409	17400	67	

Step 2: Organize the information in a table.

024 A 1991 1992 1993 1994 1996 1996 1996 1996 1997 1996 1999 2000	B STRE MEAN 1102 795 1262 731 1262 731 1782 1837 1533 2148 1409	C MAX 7470 9650 7540 8170 15500 25900 20900 8050 28300 17400	0 (OFS) 65 59 61 61 58 96 93 75 70 67	E	E	6		1		K	£	M	N
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1962 1963 1964 1965 1966 1966 1966 1969 2000	795 1262 731 1782 2088 1837 1533 2148 1409	9690 7540 8170 16500 29400 20900 9060 28200 17400	59 61 58 93 75 70 67										
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Step 3: Rank the data from largest discharge to smallest discharge. Add a column for Rank and number each streamflow value from 1 to n (the total number of values in your dataset).

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A	B	С	D	E	F:	G	()HC	1	3	K	
Fater Year	Max Streamflow, Q, (cfs)			Rank	Water Year	Ranked Max Streamflow, Q (cfs)					
1991	7470			1	1995	29400					
1992	9650			2	1999	26200					
1993	7540			3	1997	20900					
1994	8170			4	2000	17400					
1995	15500			-5	1995	15500					
1996	29400			6	1992	9650					
1997	20900			7	1994	8170					
1998	8060			8	1998	8060					
1999	28200			9	1993	7540					
2003	17400			10	1991	7470					

Step 4: Create a column with the log of each max or peak streamflow using the Excel formula {log (Q)} and copy command.

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Rank	Water Year	Banked Max Streamflow O ichi	Ion O ichi	-			- 11		4			101
1	1995	29401	A 455									
2	1999	28200	4 450									
3	1997	20900	4.300								-	-
4	2000	17400	4 741									
5	1995	15500	4,190									
6	1992	9650	3 985								-	
7	1994	8170	3.912							-	-	
В	1998	8060	3,905									
9	1993	7540	3.877									
10	1991	7470	3.873								-	
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Step 5: Calculate the Average Max Q or Peak Q and the Average of the log (Q)

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- 2	1990	29400	4,400									-	
- 6	1999	20200	4,450										-
1	2000	17400	4.325										
- 6	1995	16600	A 190									-	
6	1997	9650	3 995									-	
Ť	1994	8170	3 912										
8	1998	8060	3 906										-
9	1993	7540	3.877										
10	1991	7470	3,873										
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		15229	4.122										
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Step 6: Create a column with the excel formula { (log Q avg(logQ))^2}

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A	8	C	D	E	F	G	н	E.	- % d	(K)	1	M	N
		Ranked Max		and a second second									
Rank	Water Year	Streamflow, Q (cfs)) log Q (cfs)	(log Q -avg(logQ))*2			-						
1	1996	29400	4.468	0.120									
2	1999	26200	4.450	0.108									
3	1997	20900	4.320	0.039									
-4	2000	17400	4.241	0.014									
5	1995	15500	4.190	0.005									
6	1992	9650	3.985	0.019									
7	1994	8170	3.912	0.044									
8	1998	8060	3.906	0.047									
9	1993	7540	3.877	0.060									
10	1991	7470	3.873	0.062									
		Average	Average				-						
		15229	4.122										
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Step 7: Create a column with the excel formula { (log Q – avg(logQ)) ^3

and a second	BLav	142	. E 2 %	21 M (7) * Aris	× 10 × B Z		西田	\$ % ,	36 -3		• 🛆
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A	B	C.	D	E	E.	G	H:	- T	()) a	(K)	
lank)	Water Year	Ranked Max Streamflow, D /c%	à log 0 (chà	for 0 availantite?	deg 0. availen0043						
1	1995	29400	4.468	0.120	0.041424					-	
2	1999	28200	4.450	0.108	0.035258						-
3	1997	20900	4.320	0.039	0.007740						
4	2000	17400	4.241	0.014	0.001652						
5	1995	15500	4.190	0.005	0.000314						
6	1992	9650	3.966	0.019	-0.002617						
7	1994	8170	3.912	0.044	-0.009277						
8	1998	8060	3.906	0.047	-0.010076						
9	1993	7540	3.877	0.060	-0.014700						
10	1991	7470	3.873	0.062	-0.015442						
		Average	Average			-					
		15229	4.122								
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Step 8: Create a column with the return period (Tr) for each discharge using Excel formula $\{(n+1)/m\}$. Where n = the number of values in the dataset and m = the rank.

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A	B	- C	D	E	F	G	H	01	3	K
Rank	Water Year	Ranked Max Streamflow, Q (cfs)	log Q (cfs)	flog Q -avgflogQ0^Z	flog Q .avgflogQ()^3	Return Period				
1	1996	29400	4.488	0.120	0.041424	11.00				
2	1999	28200	4.450	0.108	0.035258	5.50				
3	1997	20900	4.320	0.039	0.007740	3.67				
4	2000	17400	4.241	0.014	0.001652	2.75				
5	1995	15500	4.190	0.005	0.000314	2.20				
Б	1992	9650	3.985	0.019	-0.002617	1,83				
7	1994	8170	3.912	0.044	-0.009277	1.57				
8	1998	8060	3.906	0.047	-0.010078	1.38				
9	1993	7540	3.877	0.060	-0.014700	1.22				
10	1991	7470	3.873	0.062	-0.015442	1.10				
		Average	Average	000000		1005				
		15229	4.122							
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Step 9: Complete the table with a final column showing the exceedence probability of each discharge using the excel formula {=1/Return Period or 1/Tr} and the copy command.

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ABC	8	C	D	E	Ŧ	G	H	1	X : 2
Rar	k Water Year	Ranked Max Streamflow, Q (cfs)	log Q (cfs)	(log Q .avg(logQ))^2	(log Q .avg(logQ))*3	Return Period, Tr = [(n+1)/m]	Exceedence Probability (1/Tr)		
1	1996	29400	4.468	0.120	0.041424	11.00	0.0909		
2	1999	28200	4.450	0.108	0.035258	5.60	0.1618		
3	1997	20900	4.320	0.039	0.007740	3.67	0.2727		
- 4	2000	17400	4.241	0.014	0.001652	2.75	0.3636		
- 5	1995	15500	4,190	0.005	0.000314	2.20	0.4545		
6	1992	9650	3.985	0.019	-0.002617	1.83	0.5455		
- 7	1994	8170	3.912	0.044	-0.009277	1.57	0.6364		
8	1998	8060	3.906	0.047	-0.010078	1.38	0.7273		
- 9	1993	7540	3.877	0.060	-0.014700	1.22	0.6162		
10	1991	7470	3.873	0.062	-0.015442	1.10	0.9091		
		Average	Average				1 19129 5000 11		
		15229	4.122						

Step 10: Calculate the Sum for the $\{(\log Q - avg(\log Q))^2\}$ and the $\{(\log Q - avg(\log Q))^3\}$ columns.

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A	-		0	¢.		G	H	21
Rank	Water Year	Ranked Max Streamflow, Q (cfs)	log Q (cfs)	flog Q .avgflogQ()*2	dog Q avgdog09*3	Return Period, Tr = [(n+1)/m]	Exceedence Probability (1/Tr)	
1	1996	29400	4.468	0.120	0.041424	11.00	0.0909	
2	1999	28200	4.450	0.108	0.035258	5.50	0.1818	
3	1997	20900	4.320	0.039	0.007740	3.67	0.2727	
4	2000	17400	4.241	0.014	0.001652	2.75	0.3636	
5	1995	15500	4.190	0.005	0.000314	2.20	0.4545	
6	1992	9650	3.965	0.019	-0.002617	1.83	0.5455	
7	1994	8170	3.912	0.044	-0.009277	1.57	0.6364	
8	1998	8060	3.906	0.047	-0.010078	1.38	0.7273	
9	1993	7540	3.877	0.060	-0.014700	1.22	0.8182	
10	1991	7470	3.873	0.062	-0.015442	1.10	0.9091	
		Average	Average	Sum	Sum	V/IDF	11.15-10-12	
		15229	4.122	0.517	0.034			

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Step 11: Calculate the variance, standard deviation, and skew coefficient as follows:

variance =

$$\frac{\sum_{i=1}^{n} (\log Q - avg(\log Q))^2}{n-1}$$

standard deviation =

$$\sigma \log Q = \sqrt{\text{variance}}$$

skew coefficient =

$$\frac{n \times \sum_{i}^{n} (\log Q - avg(\log Q))^3}{(n-1)(n-2)(\sigma \log Q)^3}$$

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A	В	0	D	E	F	G	H.	1	L
ank	Water Year	Ranked Max Streamflow, Q (cfs)	log Q (cfs)	(log Q -avg(logQ))^2	flog Q -avgflogQli*3	Return Period, Tr = lin+1/ml	Exceedence Probability (1/Tr)		
1	1996	29400	4.468	0.120	0.041424	11.00	0.0909		
2	1999	26200	4.450	0.108	0.035258	5.50	0.1818		
3	1997	20900	4.320	0.039	0.007740	3.67	0.2727		
4	2000	17400	4.241	0.014	0.001852	2.75	0.3636		
6	1995	15500	4.190	0.005	0.000314	2.20	0.4545		
6	1992	9650	3.965	0.019	-0.002617	1.83	0.5455		
7	1994	8170	3.912	0.044	-0.009277	1.57	0.6364		
8	1998	8060	3.906	0.047	-0.010078	1.38	0.7273		
9	1993	7540	3.877	0.060	-0.014700	1.22	0.8182		
10	1991	7470	3.873	0.062	-0.015442	1.10	0.9091		
		Average	Average	Sum	Sum				
		15229	4.122	0.517	0.034				
				al al and a set of the	La restance				
_			-	variance	0.0574				
_				standard deviation	0.2396				
				skew coefficient	0.3460				
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Step 12: Calculate k values

- Use the **frequency factor table** and the skew coefficient to find the **k values** for the 2,5,10,25,50,100, and 200 **recurrence intervals**
- If the skew coefficient is between two given skew coefficients in the table than you can linearly extrapolate between the two numbers to get the appropriate k value. To view the frequency factor table click on the button below.

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A	8	C	D	E	F	G	H	1	
Dank	Water Vent	Ranked Max	Inn O (cfr)	iten () medlan(00))	den 0. mmlan0043	Return Period,	Exceedence Probability (1/Tr)		
1	1996	29/00	4 AER	0.120	0.041424	11.00	n nene		_
2	1999	28200	4.450	0.108	0.047424	5.50	0.1818		
3	1997	20900	4.320	0.039	0.007740	3.67	0.2727		
Ă	2000	17400	4 241	0.014	0.001652	2.75	0.3636		
5	1995	15500	4 190	0.005	0.000314	2.20	0.4545		
6	1992	9650	3.965	0.019	-0.002617	1.83	0.5455		
7	1994	8170	3.912	0.044	-0.009277	1.67	0.6364		
8	1998	8060	3.906	0.047	-0.010078	1.38	0.7273		
9	1993	7540	3,677	0.060	-0.014700	1.22	0.8182		
10	1991	7470	3.873	0.062	-0.015442	1.10	0.9091		
	1000	Average	Average	Sum	Sum	1000	100000		
		15229	4.122	0.517	0.034				
				variance	0.0574				
				standard deviation	0.2396				
				skew coefficient	0.3460				
				2415-2-24	100000		10 Magazar		
_			Tr	K(0.3)	K(0.4)	slope	K(0.3460)	Q (cfs)	
			2	-0.050	-0.066	-0.16	-0.057		
			- 6	0.824	0.816	-0.08	0.820		
			10	1.309	1.317	0.08	1.313		
			25	1.849	1.880	0.31	1.863		
			50	2.211	2.261	0.5	2.234	6 - E	
			100	2.544	2.615	0.71	2.577		
			200	2.866	2,949	0.93	2.899		
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Step 13: Using the general equation, list the discharges associated with each recurrence interval

general equation =

$\log QTr = avg(\log Q) + [K (Tr, Cs)] \times \sigma \log Q$

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A	B	0	D	E	F	G	Н	1	1
Ran	k Water Year	Ranked Max Streamflow, Q (cfs)	log Q (cfs)	dog Q -avgdogQ@*2	flog Q -avgflogQ))*3	Return Period, Tr = [(n+1)/m]	Exceedence Probability (1/Tr)		
1	1996	29400	4.468	0.120	0.041424	11.00	0.0909		
2	1999	28200	4.450	0.108	0.035258	5.50	0.1818		
- 3	1997	20900	4.320	0.039	0.007740	3.67	0.2727		
- 4	2000	17400	4.241	0.014	0.001652	2.75	0.3636		
- 5	1995	15500	4.190	0.005	0.000314	2.20	0.4545		
6	1992	9650	3.985	0.019	-0.002617	1.63	0.5455		
- 7	1994	8170	3.912	0.044	-0.009277	1.57	0.6364		
8	1996	8060	3.906	0.047	-0.010078	1.38	0.7273		
9	1993	7540	3.677	0.060	-0.014700	1.22	0.8182		
10	1991	7470	3.673	0.062	-0.015442	1.10	0.9091		
		Awerage	Average	Sum	Sum				
		15229	4.122	0.517	0.034				
	_								
				variance	0.0574				
				standard deviation	0.2396				
				skew coefficient	0.3460				
	-		Te	1/0.3	100.45	clone	1/0 3480	0.665	
			2	-0.050	-D 065	.0.16	0.057	17941	
5			- <u>2</u>	0.924	000.00	-0.10	0.007	20941	
			5	1 300	1 317	0.06	1.313	27346	
			36	1.849	1.890	0.00	1.953	37063	
		-	50	2.211	2.261	0.5	2 234	45463	
8			100	2.544	2.615	0.71	2.577	54906	
			200	2.856	2.949	0.93	2,899	65608	
		1	100	2.0.00	2.040	0.55	2.000		
-	success data	1 10001	_		(del				
ALC: NO	And the second second	and a second							-

Step 14: Create table of Discharge values found using the log -**Pearson analysis**

			• P • • F = F = 0 + 0 >							
0	-									
A	В	C .	D	E	F	0	H -	T	1	
Flood Frequency Calculations using log Pearson Analysis III										
leturn Period	Skew Coefficient	Discharge								
(years)	K(0.3460)	Q (cfs)								
2	-0.057	12841								
5	0.820	20841								
10	1.313	27346								
25	1.863	37053								
50	2.234	45463								
100	2.577	54925								
200	2.899	65608		-						
	0.0000	246000X 112								
							_			
								-		
								-		

Step 15: Create Plot



Analysis Techniques: Flood Frequency Analysis Tutorial with Daily Data from Streamflow Evaluations for Watershed Restoration Planning and Design, http://water.oregonstate.edu/streamflow/, Oregon State University, 2002-2005. - 10 -

• Below is a comparison of flood frequency analysis completed using mean daily data versus instantaneous discharge data. As can be seen, had you completed this analysis using instantaneous peak discharge data, the result would have been a more conservative estimation of the discharges associated with each return period.



Analysis Techniques: Flood Frequency Analysis Tutorial with Daily Data *from* Streamflow Evaluations for Watershed Restoration Planning and Design, http://water.oregonstate.edu/streamflow/, Oregon State University, 2002-2005.