

Step by Step Guide to Hydrological Estimation

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Introduction:

Research by Ilhardt *et al.* (2000) determined the 50-year floodplain was the optimal hydrologic descriptor of a riparian ecotone along a moving watercourse. This flood recurrence interval was selected because the 50-year flood elevation, in most cases, intersects the first terrace or other upward sloping surface and supports the same microclimate and geomorphology as the stream channel. The 50-year flood plain also coincides with measurements that quantify a valley to its stream via two measurements: the entrenchment ratio (valley width at the first terrace or up slope to the stream width at full bank); and the belt width ratio visible on aerial photos or maps.

Before running the model, a determination of an appropriate 50-year flood height is necessary and is a critical input into the model. Mason (2007) explained the hydrological estimation of the 50 year flood height in a simple straight forward method and is illustrated below. The calculations are derived from Bedient and Huber (2002).

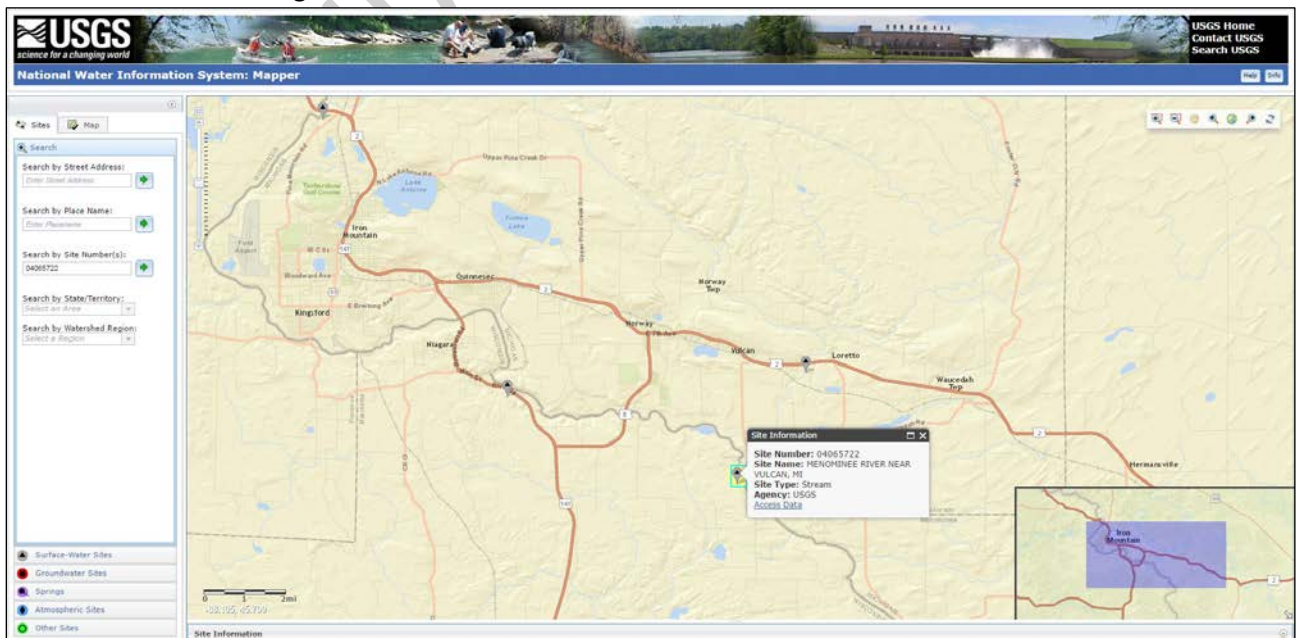
Basic Information:

- Locate all gauging stations within or in close proximity of your study area using HUC-6, 8, 10, or 12 digits layer as a reference.
- Download required data (Annual Statistics and Field Measurements data) per each gauge.
- Calculate 50-year flood height per each gauge utilizing the 50-year flood height calculations below.

50-Year Flood Height Calculations:

A sample calculation of 50-year flood height for gauging station 04065722 is presented below.

1. Go to USGS Water Data for the Nation <https://waterdata.usgs.gov/nwis>.
2. Click on the map viewer.
3. Locate USGS gauge station 04065722 using “Search by Site Number(s)”
4. Click on the gauging station of interest and a new page will open with station information including its gauge number (a unique identifier).
5. Click “Access Data” to access the gauging station website which contains a complete description of the selected station including station location and available data.



- Select "Annual Statistics" which includes the annual average discharge (ft³/sec.) rate. Save to a Tab-separated data file.

USGS Surface-Water Annual Statistics for the Nation

USGS 04065722 MENOMINEE RIVER NEAR VULCAN, MI

Available data for this site Time-series: Annual s

Site Selection

Select sites which meet all of the following criteria: ---- or select [new criteria](#)

Check one or more boxes to select sites/parameters for further display--below:

USGS 04065722 MENOMINEE RIVER NEAR VULCAN, MI

	Parameter Code	Parameter Name
<input checked="" type="checkbox"/>	00060	Discharge, cubic feet per second

Choose Output Format

Retrieve USGS Surface-Water Annual Statistics for Selected Sites
Choose one of the following options for displaying data for the sites meeting the criteria above

Date range for statistics calculation of all selected parameters -- From: (YYYY) To: (YYYY)
If blank, use entire period of record for each parameter.

Use incomplete data for statistics calculation

Annual statistics based on Water Year

Table of annual mean

Tab-separated data YYYY-MM-DD Save to file *

* Save compressed files with a .gz file extension.

- Next, select "Field Measurements. The output format must include channel data. This provides periodic measurements of channel flow (ft³/sec), channel width (ft.) and channel velocity (ft/sec). Save to a Tab-separated data file.

Streamflow Measurements for the Nation

USGS 04065722 MENOMINEE RIVER NEAR VULCAN, MI

Available data for this site Surface-water: Field measurements GO

Dickinson County, Michigan
Hydrologic Unit Code 04030108
Latitude 45°44'12", Longitude 87°51'48" NAD27
Drainage area 2,900 square miles
Gage datum 820 feet above NGVD29

Output formats

[HTML table with channel data](#)

[HTML table without channel data](#)

[Tab-separated data with channel data](#)

[Tab-separated data without channel data](#)

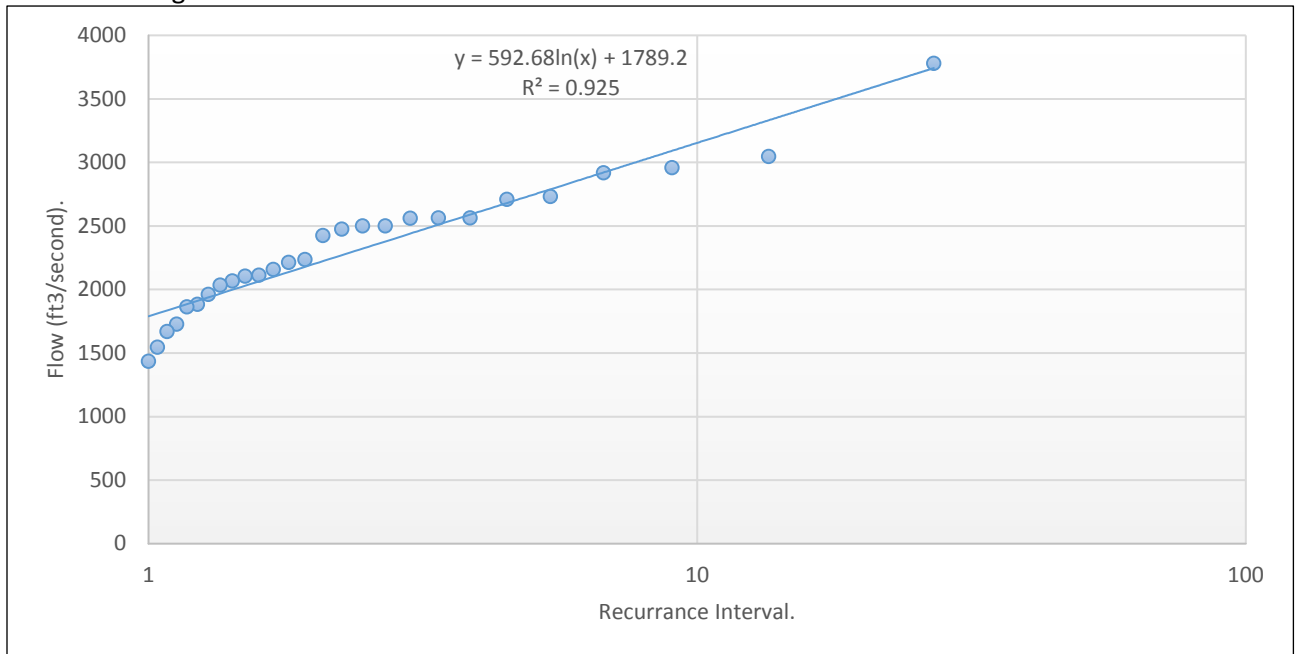
[Graph of data](#)

[Reselect output format](#)

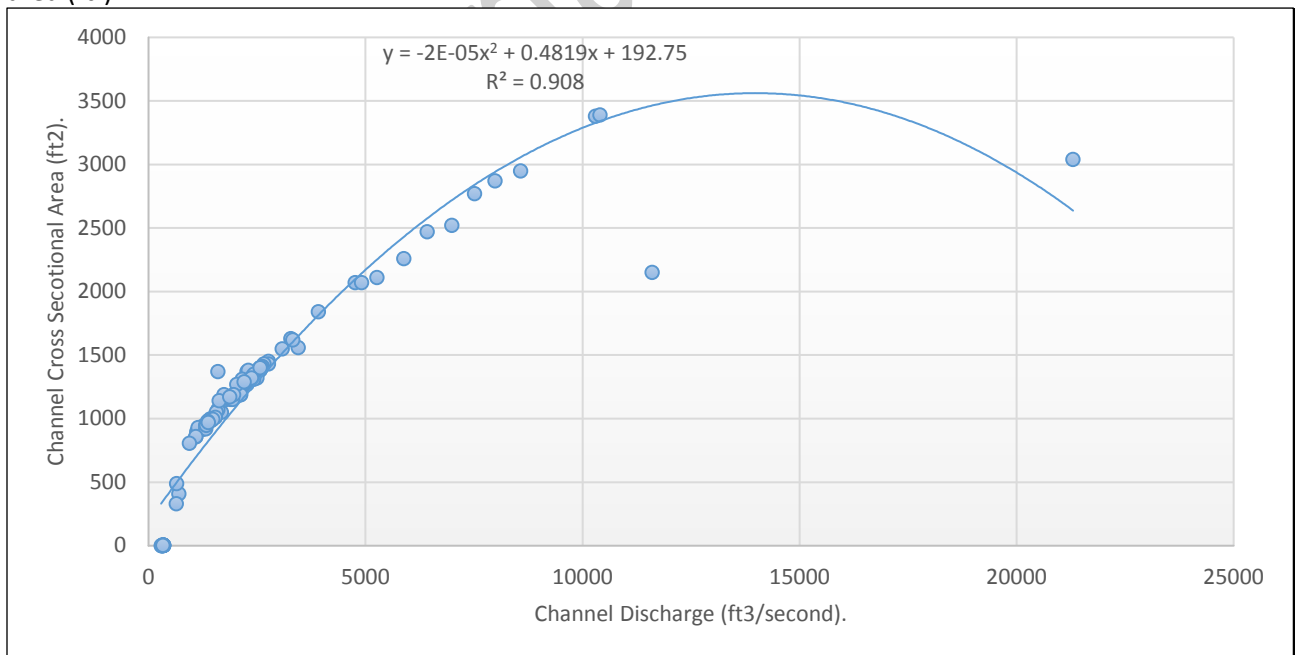
Meas. Number	Date	Time	Time Datum	Measurement Used?	Who	Measuring Agency	Stream flow (ft ³ /s)	Gage Height (ft)	Rating No.	Shift Adj. (ft)	% Diff.	GH Change (ft)
158	2017-03-17	08:38:50	CST	Yes	DJC/db	USGS	3590	7.23	5.1	0.10	7.5	-0.03
157	2017-01-20	09:48:47	CST	Yes	DJC/dab	USGS	2250	6.23	5.1	0.10	0.4	0.00

- Use the "Hydrologic_Estimation" Excel file to complete the calculations.
- Copy "Annual Statistics" data into "Hydrologic_Estimation" Excel file. Paste Special (values) the data into "Year" and "Annual Flow (ft³/s)" columns (green area).

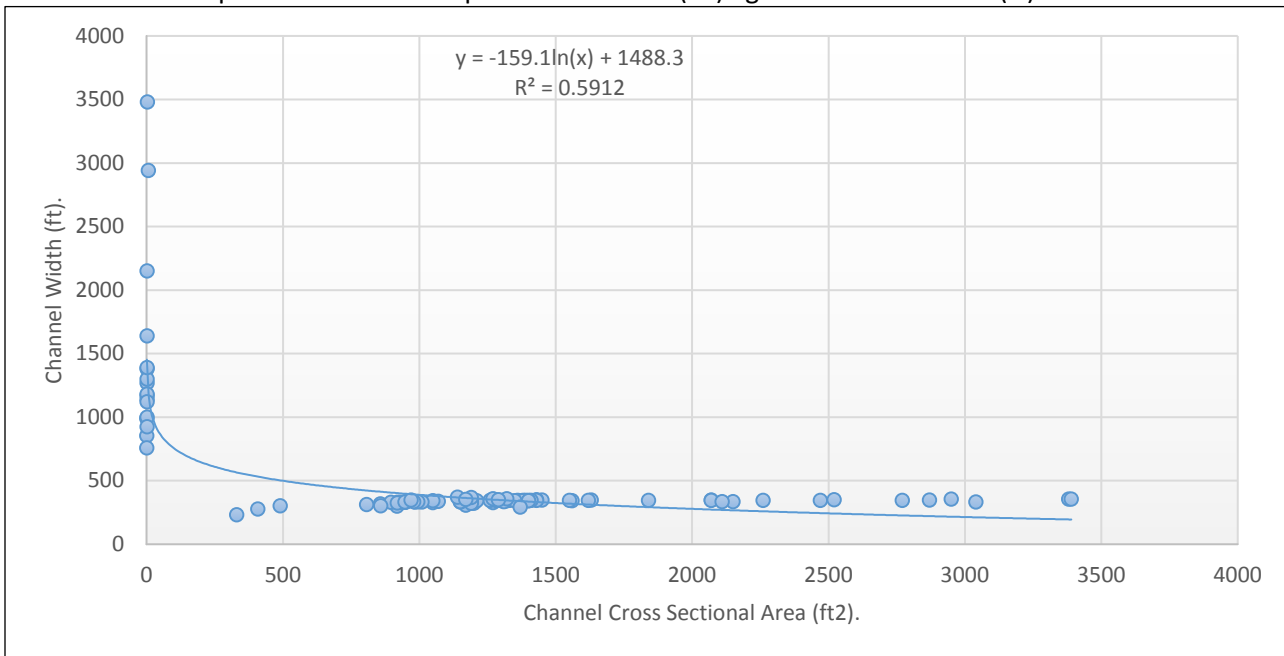
10. Click “Calculate Equation-1” button to rank the measurements so the fastest flow rate receives a value of 1 then calculates the recurrence interval by dividing the rank number by the number of measurements. Plot the flow rate against the logarithmic recurrence interval years to develop a flood occurrence regression as illustrated below.



11. Copy data from “measurements” file to “Field Measurements” section within “Hydrologic_Estimation” Excel file (red area). Use Paste Special (Value). Remove entire row if it contains text, special characters, or zeros.
12. Click “Calculate Equarion-2” button to plot channel flow (ft³/sec) against the channel cross sectional area (ft²).



13. Click "Calculate Equation-3" button to plot channel area (ft²) against channel width (ft).



14. Type the coefficients for each equation as illustrated.

Mason 2007 Claculations	Coefficients		
Equation-1 $y = 592.68\ln(x) + 1789.2$ $R^2 = 0.925$	c	b	
	592.68	1789.2	
Equation-2 $y = -2E-05x^2 + 0.4819x + 192.75$ $R^2 = 0.908$	c2	c1	b
	0.00002	0.4819	192.75
Equation-3 $y = -159.1\ln(x) + 1488.3$ $R^2 = 0.5912$	c	b	
	-159.1	1488.3	

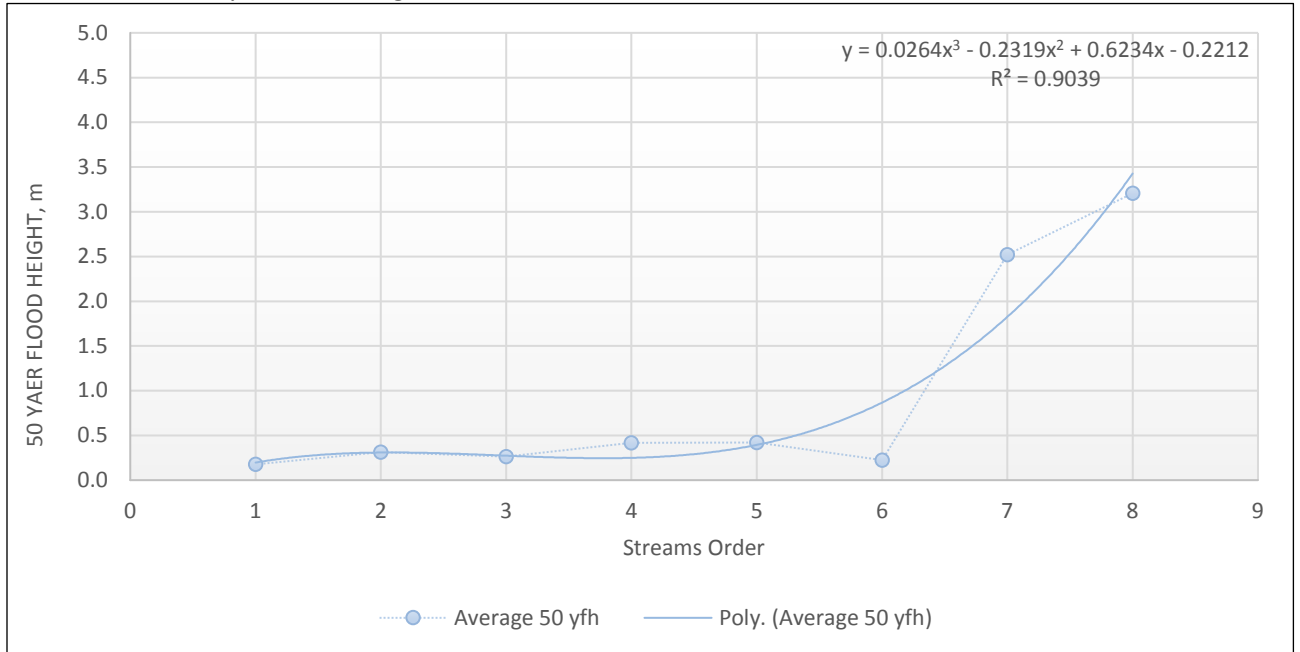
15. The 50-year flood height will be calculated automatically. Year one is calculated as a reference.

	1	50	100
b	1789.2	4107.777795	8239.570497
192.75	1118.990213	2509.764888	34305738.74
	371.3890499	242.8740527	25823.23018
Flood Height (ft)	3.01	10.33	1328.48
Flood Height (meter)	0.92	3.15	404.92

16. Repeat the same steps for other gauges.

50-Year Flood Height vs. Stream order:

1. Locate each gauge to its stream order using ArcGIS.
2. Plot calculated 50-year flood height vs. identified streams order as illustrated.



3. Estimate 50-year flood height values from the polynomial equation for streams order without gauges.
4. Create a new field such as "FloodData" inside streams layer attribute table. The new field should have a "float or double" field type.
5. Populate "FloodData" field with 50-year flood height values for each stream order as illustrated. the streams attribute table should look like below.

ReachCode	FType	FCode	Shape_Length	StreamLeve	FloodData
04070007003930	558	55800	458.908594	3	0.75
04070007003931	558	55800	175.620519	3	0.75
04070007002087	558	55800	168.879008	4	1.5
04070007003932	558	55800	554.993633	3	0.75
04070007002087	460	46006	145.739779	4	1.5
04070007002087	460	46006	247.083598	4	1.5
04070007002087	460	46006	214.626639	4	1.5
04070007000565	460	46006	1479.038735	3	1
04070007000567	460	46006	2127.016664	3	1
04070007000087	558	55800	4673.628436	2	0.5
04070007000121	558	55800	17.983603	2	0.5
04070007000166	558	55800	21.867946	3	0.75
04070007000565	558	55800	10.323687	3	0.75
04070007000086	558	55800	5830.316587	2	0.5