New Regional Skew for California- Implications for Flood Frequency Analysis

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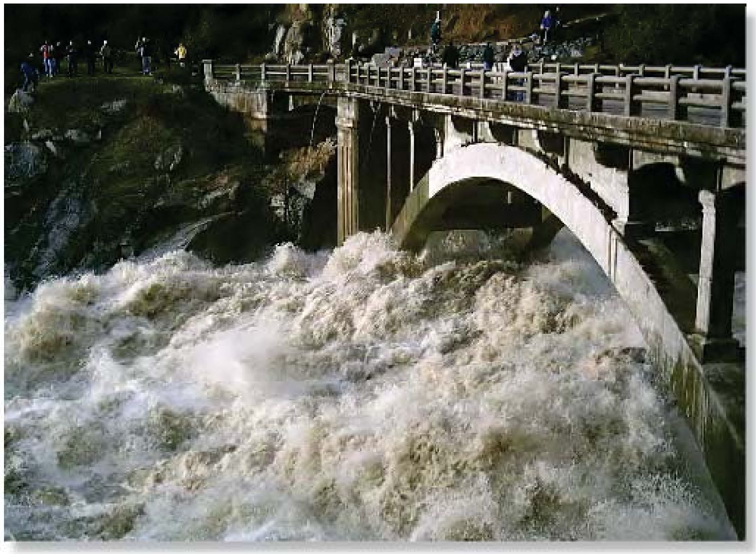
Prepared in cooperation with the Federal Emergency Management Agency, the U.S. Army Corps of Engineers, and the U.S. Forest Service

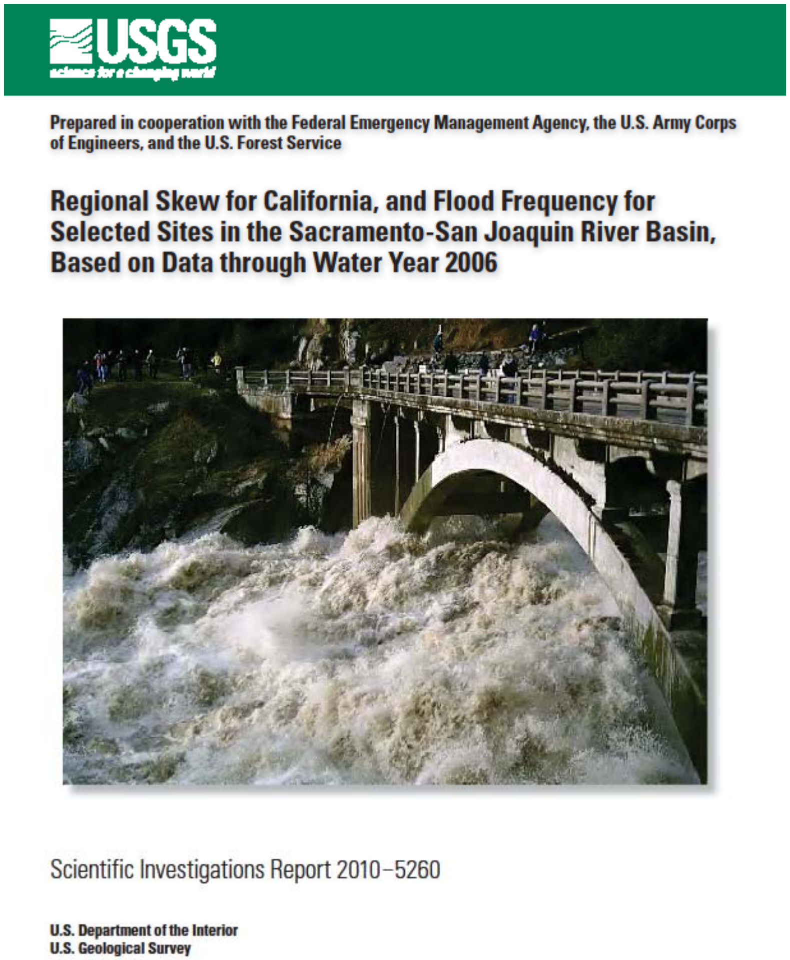
Regional Skew for California, and Flood Frequency for Selected Sites in the Sacramento-San Joaquin River Basin, Based on Data through Water Year 2006



Scientific Investigations Report 2010–5260

U.S. Department of the Interior
U.S. Geological Survey

New Report is First of Two..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First report describes new regional skew and provides updated flood frequency for 364 sites.

Second report will provide new regional estimation equations and updated flood frequency for another +300 sites.

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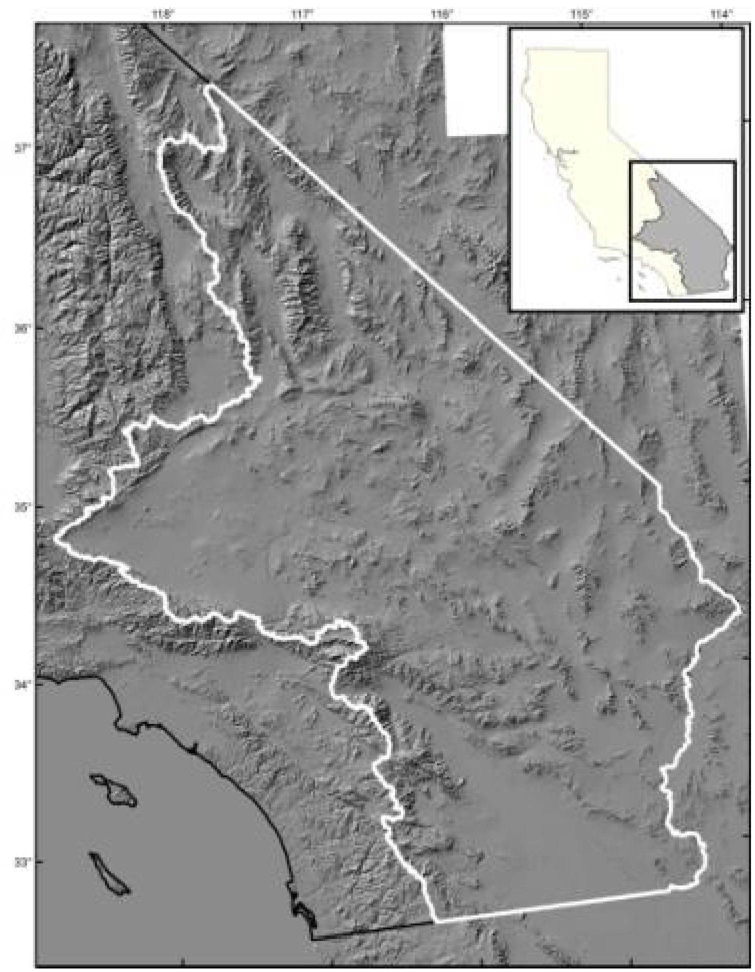
New Regional Skew **Not** Determined for California Desert..



Few sites in California desert with long-term (+30 yrs) record..

Flood-frequency complicated by numerous zero flows

Second report will provide updated flood frequency for desert sites

Flood Frequency – Associating Stream Discharge with Probability of Exceedance

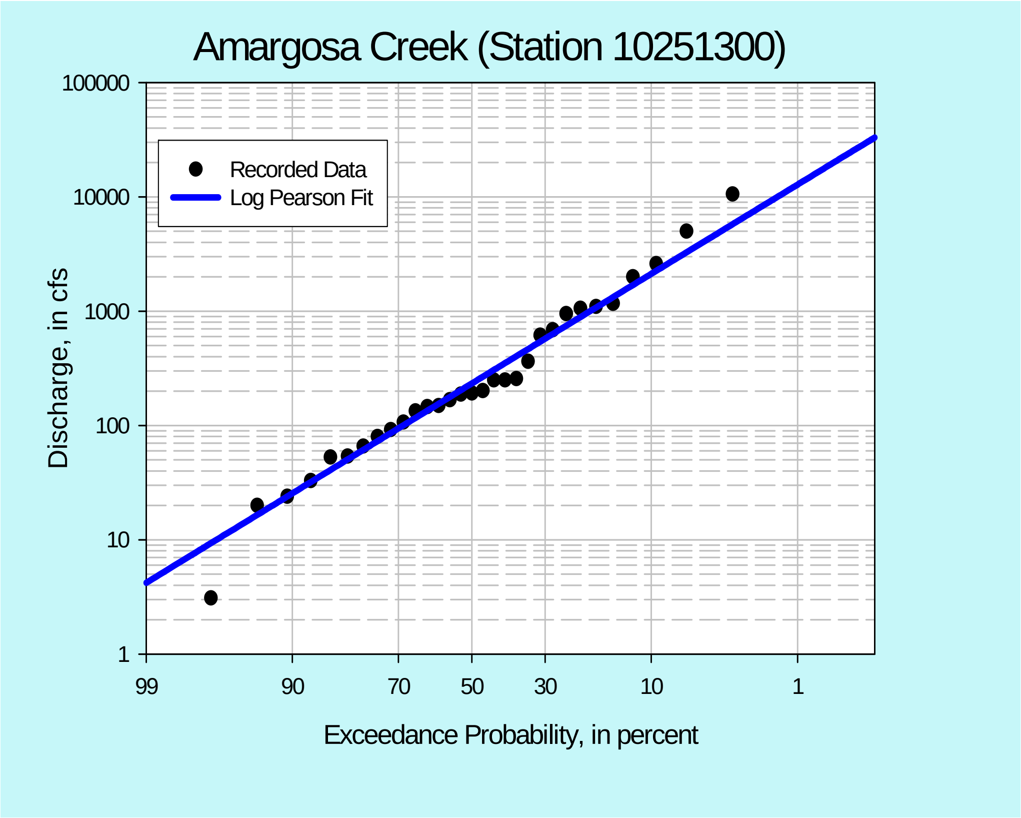
1938 flooding in southern California

Eg., Annual maximum discharge with a 0.01 (1-percent) exceedance probability is expected to be exceeded, on average, once every 100 years.

Flood Frequency at Gaged Sites– Statistical Analysis of Recorded Annual Peak Discharges

Fit a probability distribution to the sample (recorded) data

Distribution used in the U.S. is called the log Pearson 3 (described in Bulletin 17B)



Steps in Fitting the Log Pearson 3 (LP3) Distribution…

- Convert annual peak discharges to logs

- Compute Mean (M), Standard Deviation (S), and Skew (G) of the logs

- Use the basic equation described in Bulletin 17B

$$\text{Log } Qp = M + kS,$$

where Qp is the peak discharge for some probability p, and k is a function of G and the probability

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Complications to the Simple Application of Basic Equation…

•Skew (G), computed by cubing the data, is notoriously sensitive to large values and is unreliable for small samples.

•Accurate fitting of LP3 also is complicated by outliers (especially zero flow), short records, historical flood information, mixed flood populations, data trends, etc. A new fitting method, (EMA) was used in the USGS study.

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Bulletin 17B Recommends Weighting the Station (Sample) Skew (G) with a Regional Skew (Gr)

•Determine the regional skew from an analysis of long-term gages in the area.

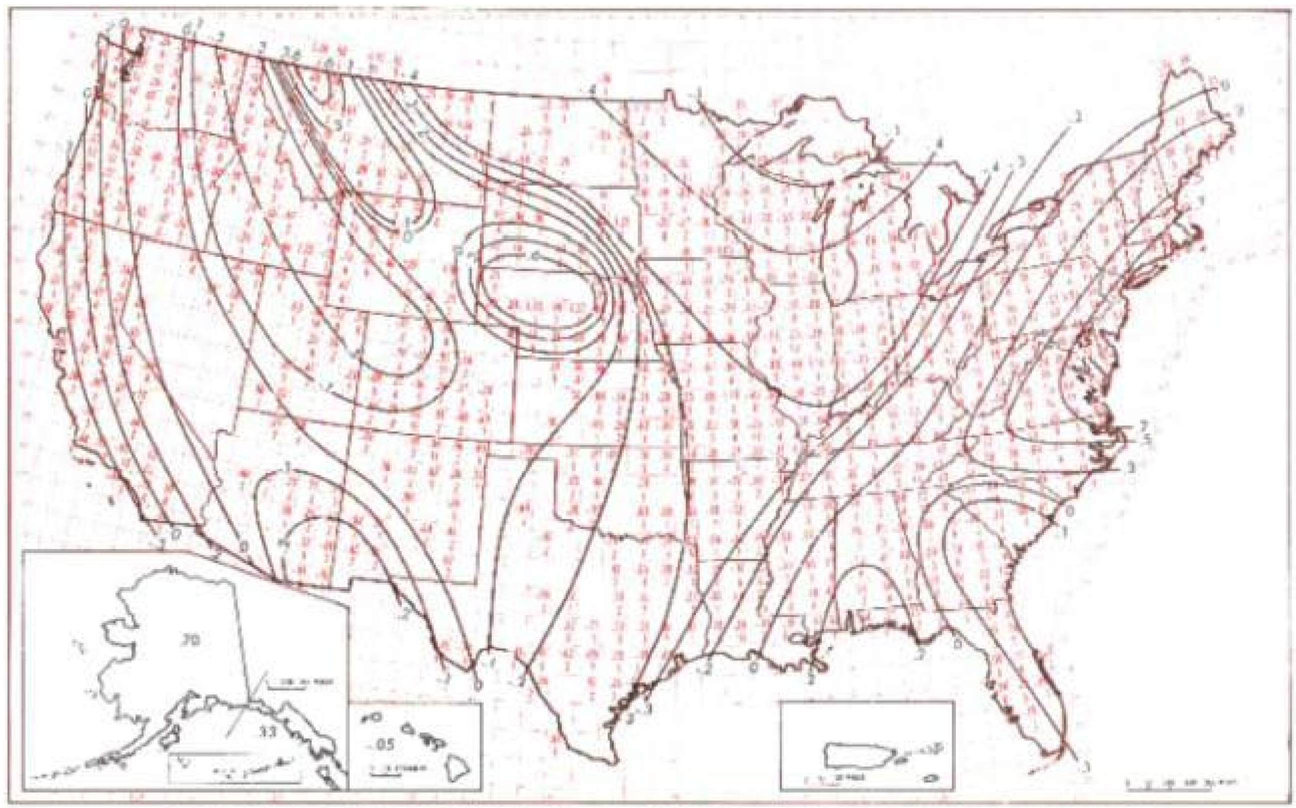
•Weight the Station and Regional skews with weights that are inversely proportional to the variances of the values.

Bulletin 17B Also Provided a National Map...

National map Commonly gets Used

National map Developed in 1974

Variance equal To about 17 Years of data



GENERALIZED SKEW COEFFICIENTS OF LOGARITHMS OF ANNUAL MAXIMUM STREAMFLOW

AVERAGE SKEW COEFFICIENT BY ONE DEGREE QUADRANGLES

Lower number in each quadrangle is number of stream gaging stations for which the average shown above it was computed

New Method for Determining Regional Skew Developed by Researchers at Cornell

- Uses Generalized Least Squares (GLS) regression to relate Regional skew to some measurable basin characteristic.

- The model error for the regression typically is small compared to sampling error of at-site skew.

- Considerably more weight is given to Regional skew, even if the GLS equation is poor.

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New Method for Determining Regional Skew Developed by Researchers at Cornell

•Previous USGS/Cornell study in the Southeastern U.S. found that regional skew was a constant (near zero), but the variance (based on model error) was equivalent to 39 years of data.

•USGS and Cornell researchers jointly worked on the new California regional skew analysis.

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California Regional Skew Analysis Was More Complicated than The Analysis in Southeastern U.S.

More interstation correlation of annual peak discharge.

GLS regression found a significant relation between basin elevation and skew—reflects a complex interaction of rain and snow on flood peaks.

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Relation Between Skew and Elevation is Non-linear..

$$G = 0.68 - 1.3e^{-(ELEV/6500)^2}$$

•Regional Skew varies from -0.62 to +0.62.

•Variance ranges from 52 to 65 equivalent years of record (EYR).

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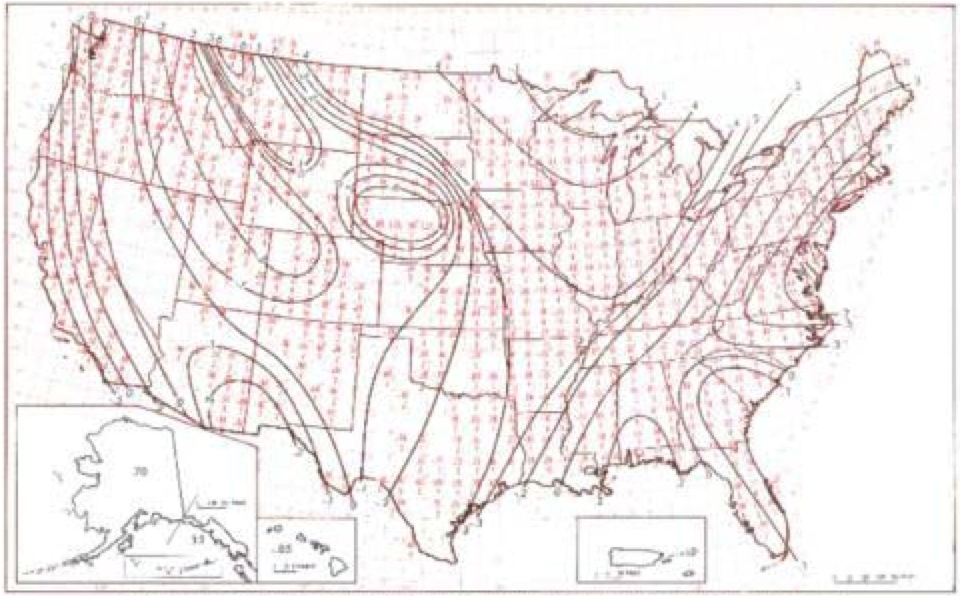
Conceptually, How Does New Regional Skew Compare to Bulletin 17B Regional Skew ?

New regional skew is physically based (snow/rain interaction)

$$G = 0.68 - 1.3e^{-(ELEV/6500)^2}$$

vs



GENERALIZED SKEW COEFFICIENTS OF LOGARITHMS OF ANNUAL MAXIMUM STREAMFLOW
AVERAGE SKEW COEFFICIENT BY ONE DEGREE QUADRANGLES

Error of new regional skew correctly distinguishes model error from sampling error.

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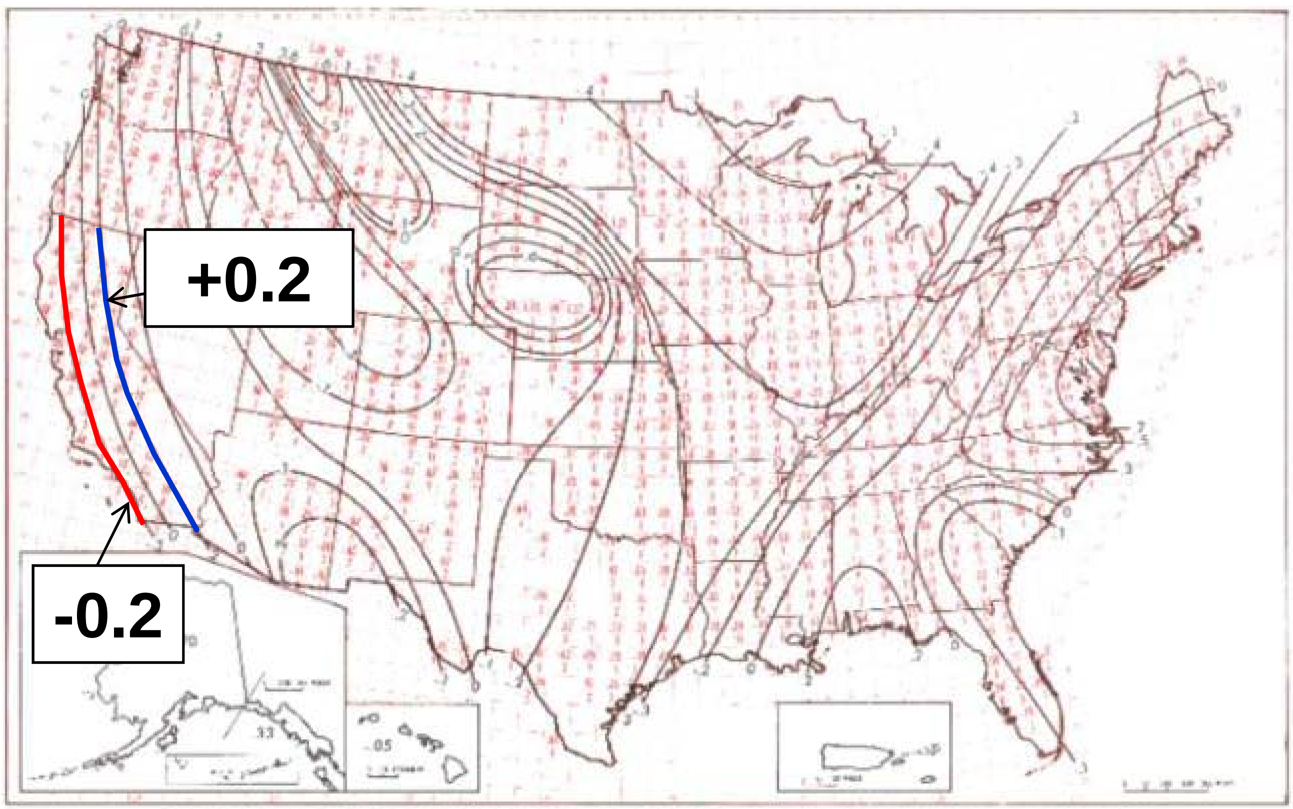
Practically, How Does New Regional Skew Compare to Bulletin 17B Regional Skew ?

Less variability In Bulletin 17B Map

Less Weight Given To Bulletin 17B Skew (EYR = 17)



GENERALIZED SKEW COEFFICIENTS OF LOGARITHMS OF ANNUAL MAXIMUM STREAMFLOW
AVERAGE SKEW COEFFICIENT BY ONE DEGREE QUADRANGLES

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Summary of Differences Between Bulletin 17B Skew and New Regional Skew …

•Bulletin 17B skew ranges from -0.2 to +0.2.

•New regional skew ranges from -0.62 to +0.62

•Largest Bulletin 17B skew occurs in roughly the same location as new skew (along the Sierra crest)

•Smallest Bulletin 17B skew occurs about where the new skew is smallest (along the coast line)

•Significantly more weight given to new regional skew (EYR is 52 to 65 yrs vs 17 yrs for Bulletin 17B skew)

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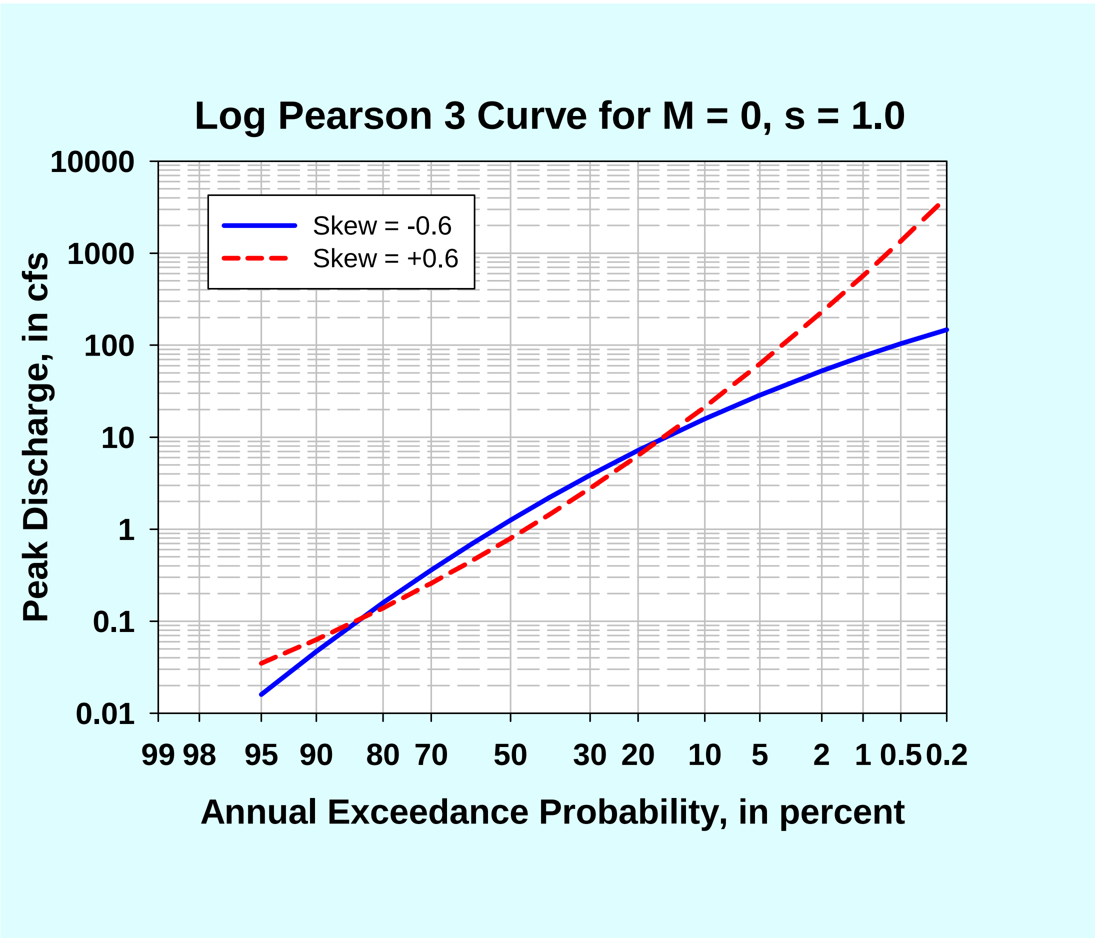
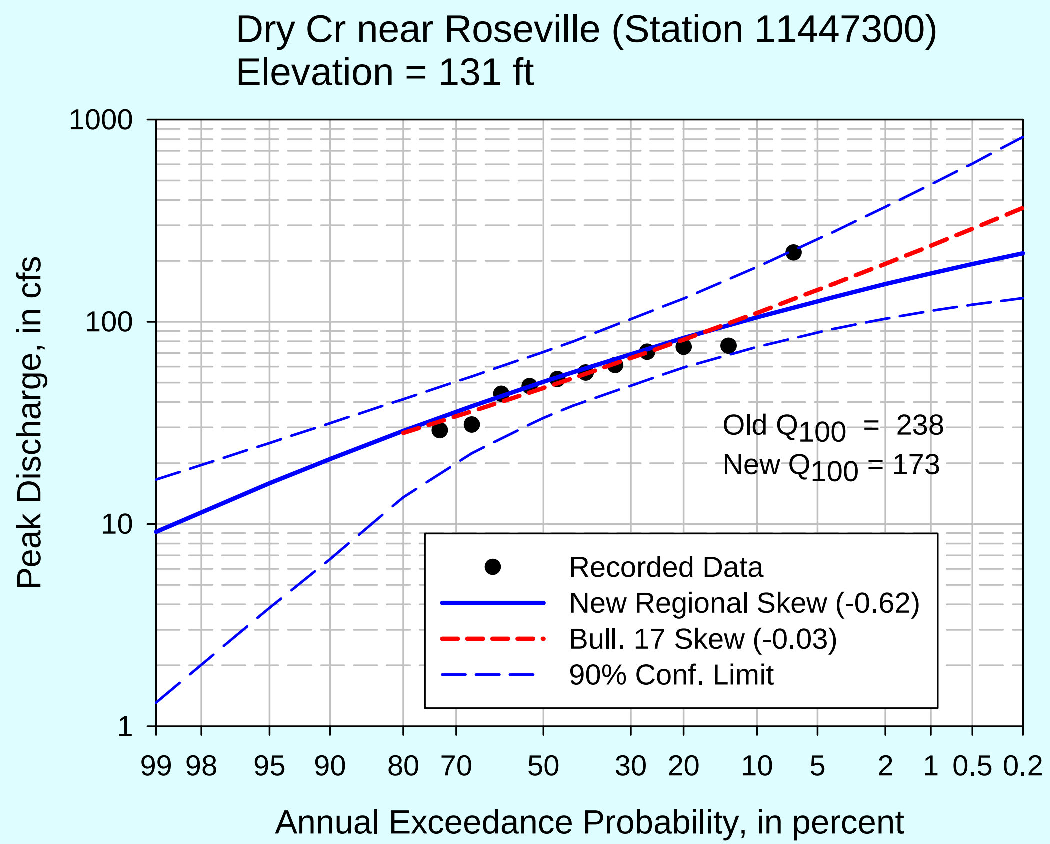
Expected Differences in Flood Frequency Resulting From Regional Skew Differences



$Q_{1\%}$ larger for higher elevations and shorter record length

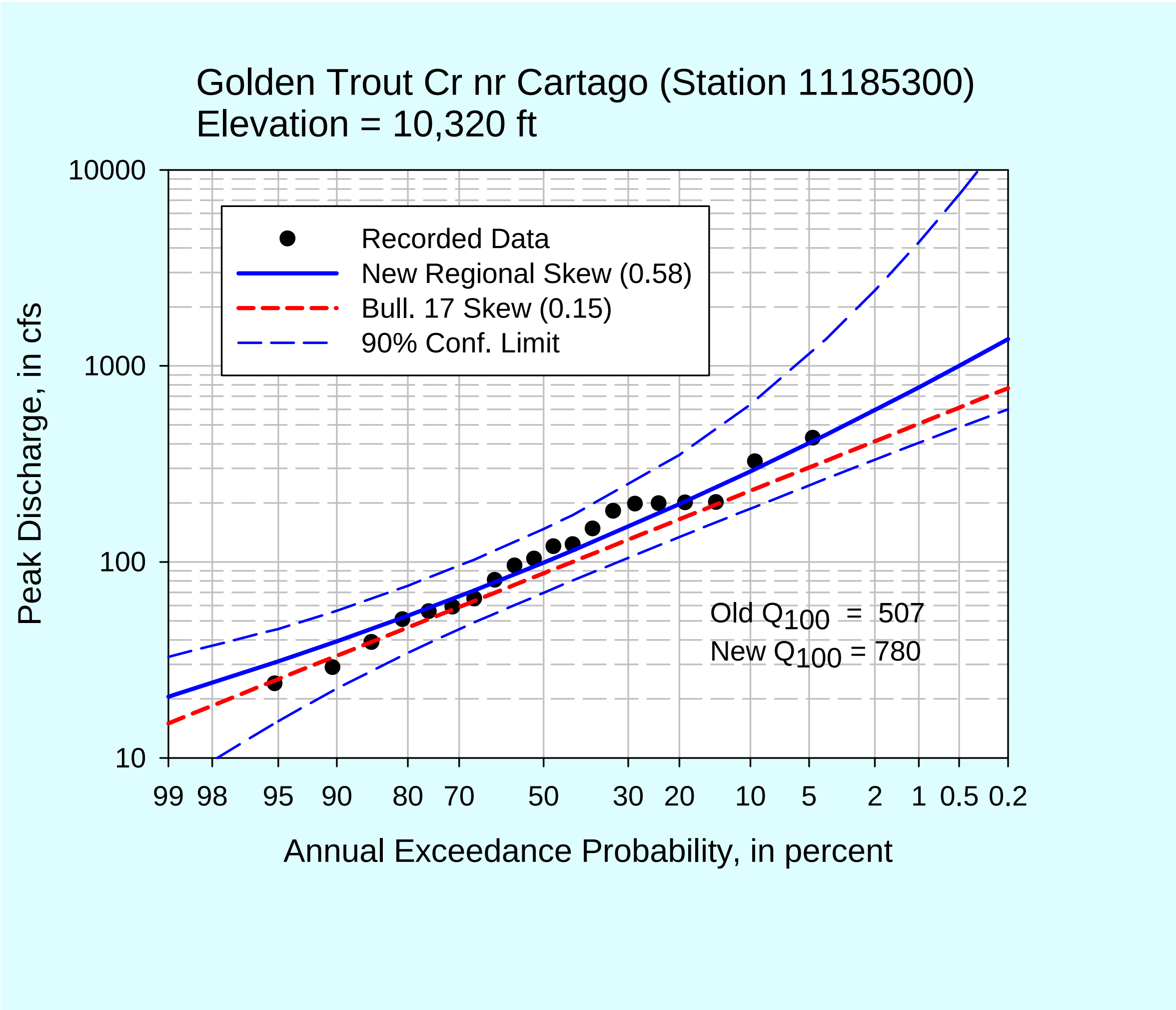
$Q_{1\%}$ smaller for lower elevations and shorter record length

Some Real Examples



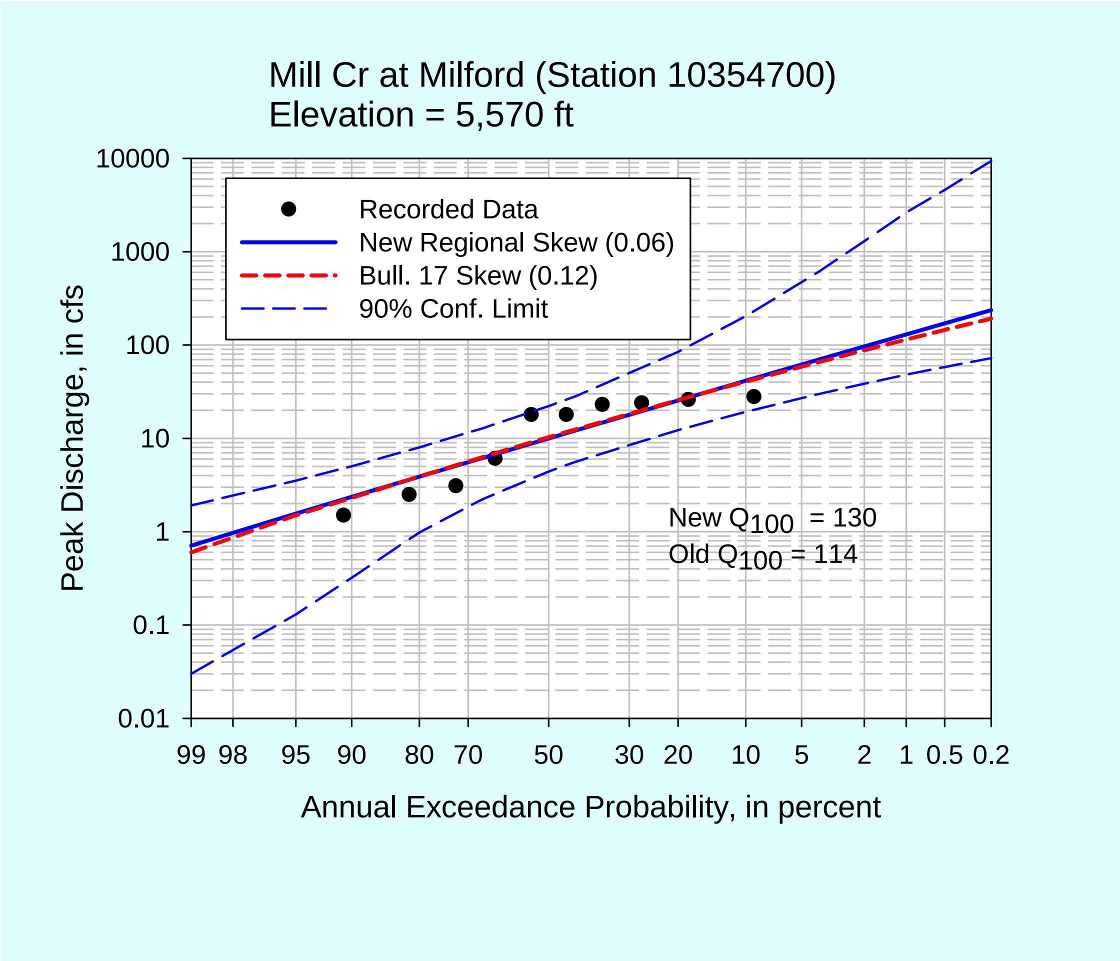
Very low elevation AND very short record

Some Real Examples



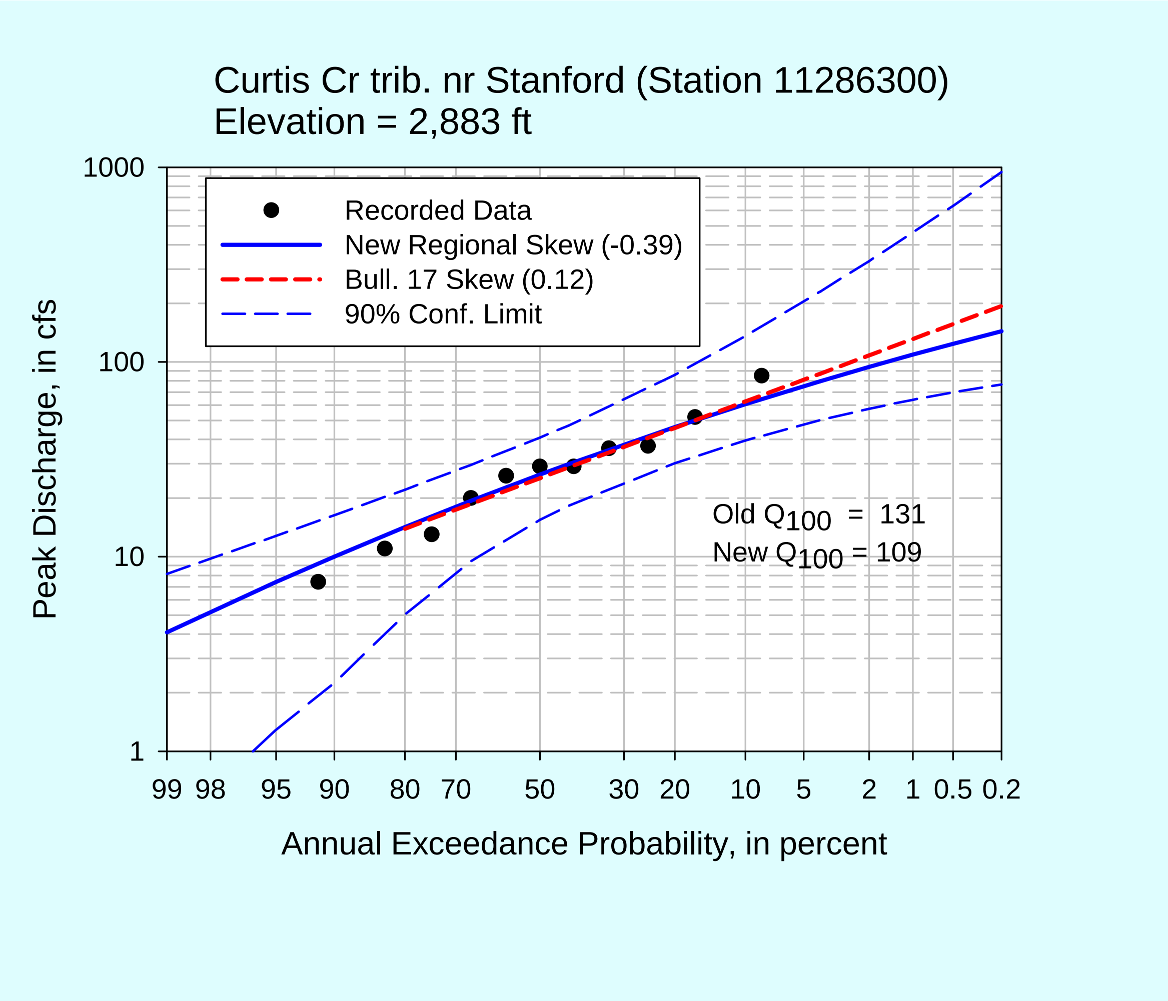
Very high elevation AND relatively short record

Some Real Examples



Moderately high elevation AND relatively short record

Some Real Examples



Moderately low elevation AND very short record

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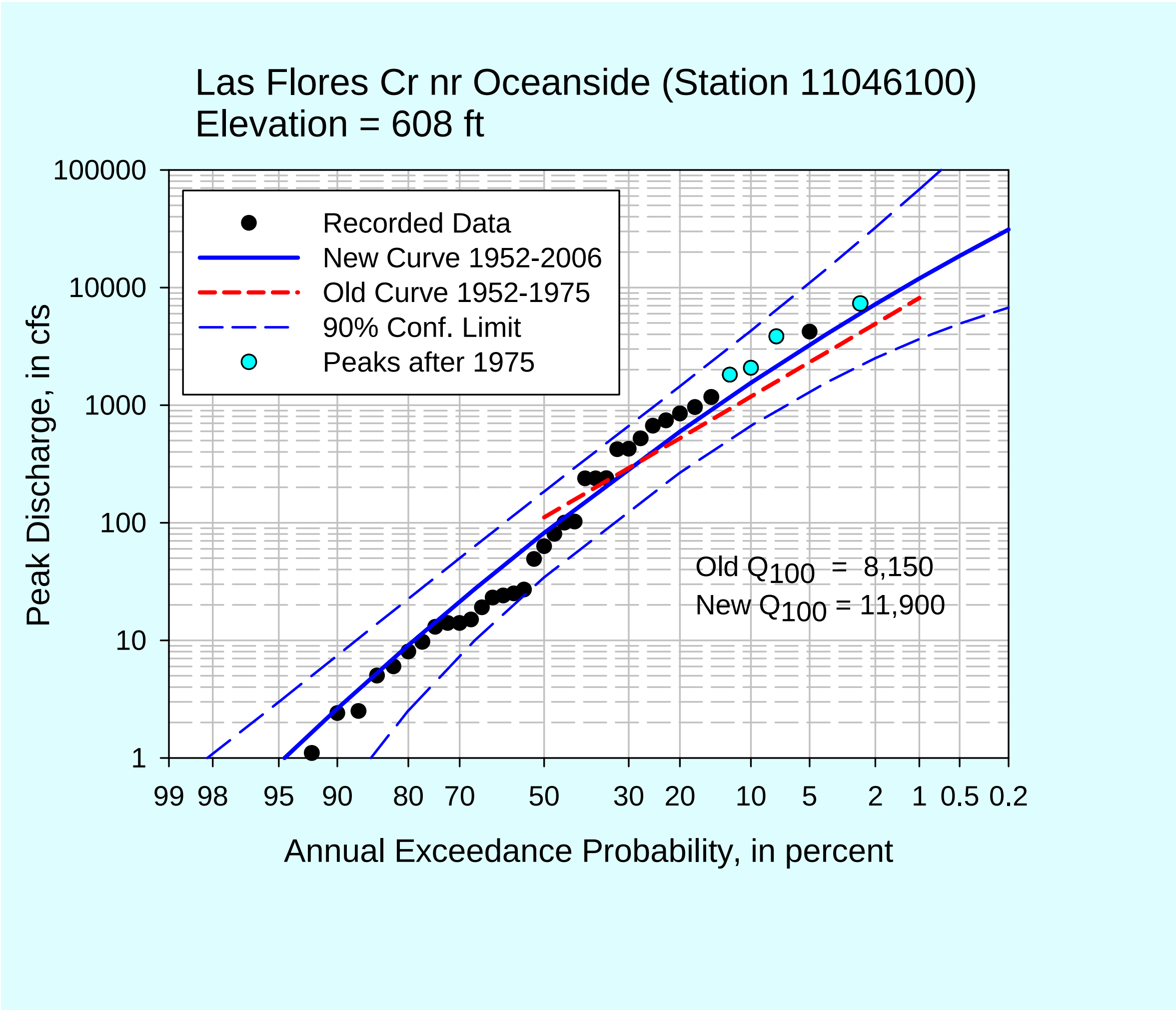
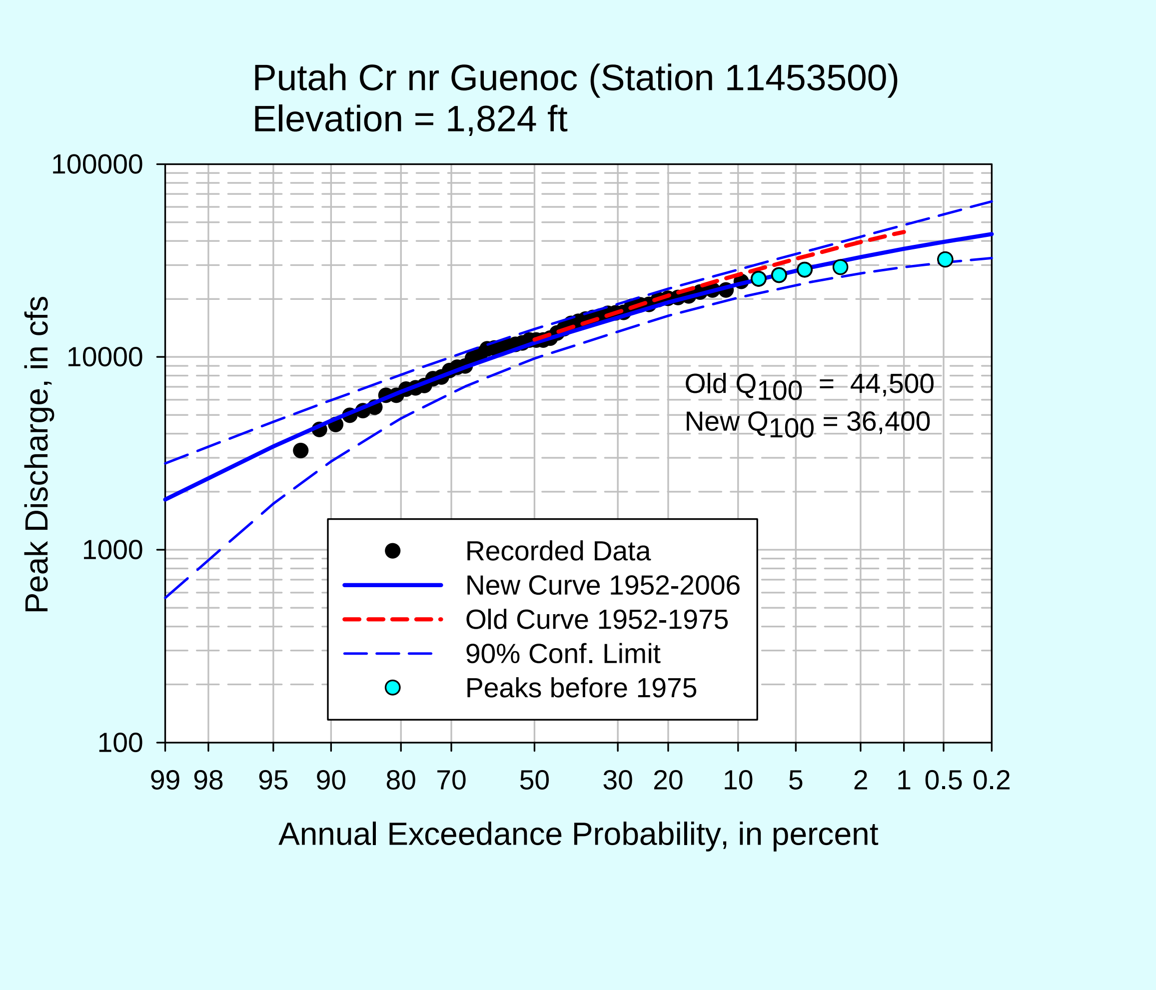
Some Real Examples



Old USGS report (1977) Vs new report

Differences due to additional flood record

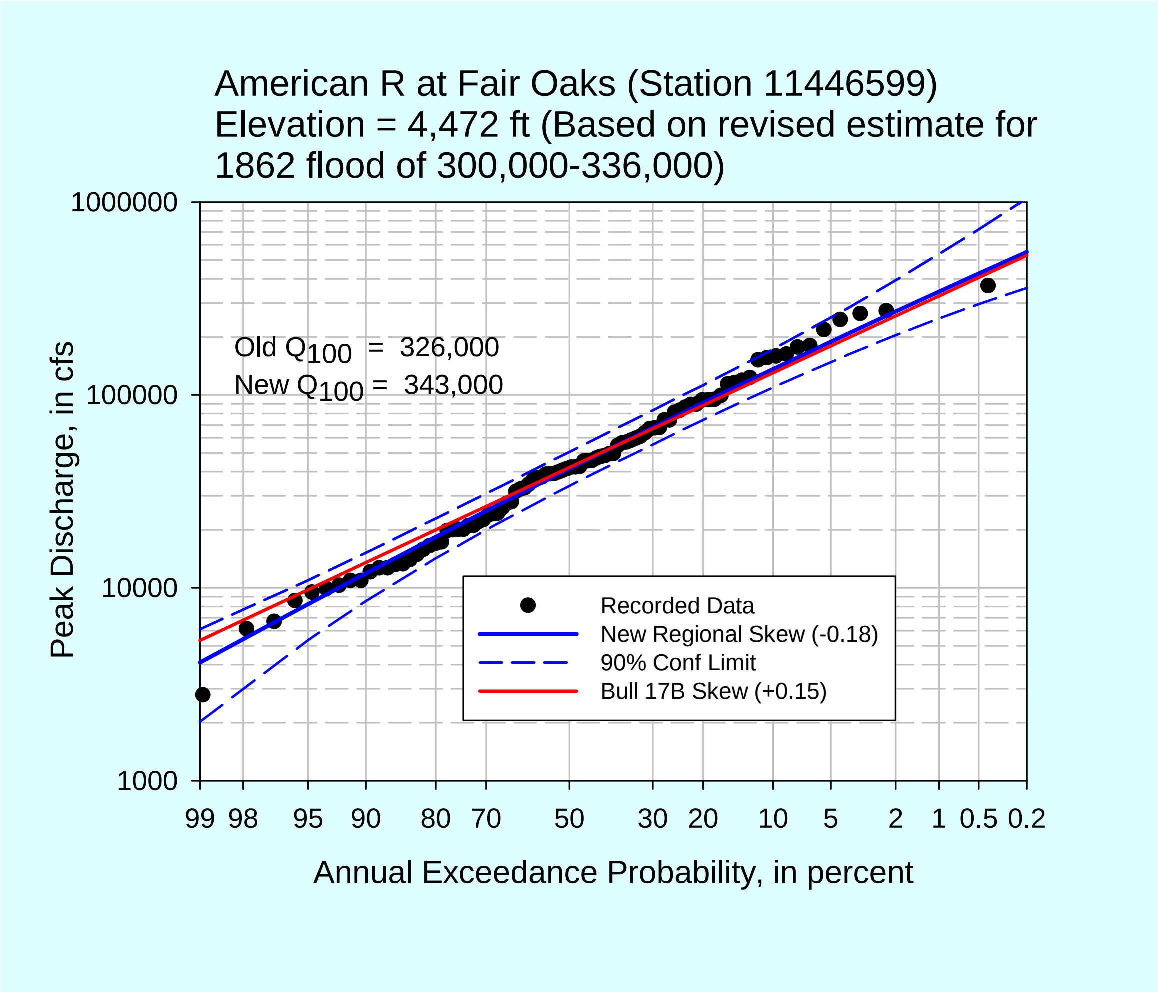
Some Real Examples



Old USGS report (1977) Vs new report

Differences due to additional flood record

One Last Example….



Recorded peaks 1905-1954

Simulated peaks 1955-1998

Revised estimate For 1862 = 318,000

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Summary of Flood-Frequency Effects of New Regional Skew..

- Depending upon record length and effects of historical information and outliers, Q_{100} tends to be larger at higher elevations
- Depending upon record length and effects of historical information and outliers, Q_{100} tends to be smaller at lower elevations
- Overall, changes to flood frequency are modest

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What's Coming Next (Over the Next 6 mos.)?

- Flood-frequency results for +300 more sites (including the desert region).
- Regression equations for estimating flood frequency at ungaged sites (including the desert region).
- StreamStats web page available for calculating flood frequency at the click of a mouse . . .

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The End…..