Lab 12 : Flooding II -- Predicting and Understanding Flooding

Introduction

Knowledge of the timing of flooding events is important for a variety of planning purposes. The time between floods of similar size is the recurrence interval. It is calculated from historical data collected along a stream for a long period of time. The long the period of data collection the better the prediction.

Stream Gage

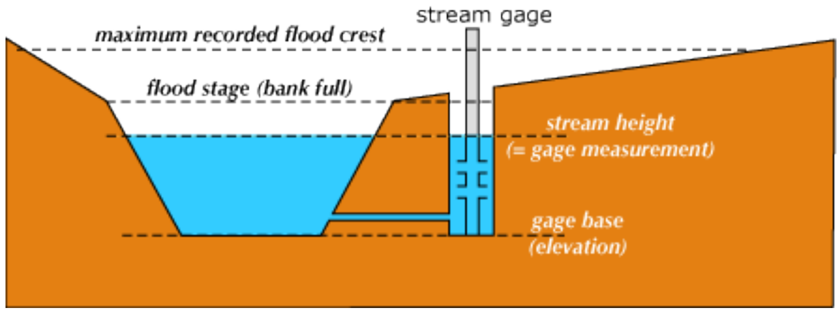
Efforts to planning for flooding along a particular stream requires a historical record of how the stream has acted in the past. Using this data and the assumption that the stream will behave similarly in the future, the record can be used to predict future stream behavior, e.g. its flood heights and frequencies.

A stream in flood covering a dirt road.

This type of data is used to plan engineering solutions to flooding, e.g. dams, levees, etc., as well as to define flood zones for establishment of flood insurance zones.

Stream Gages

Stream gages are placed on streams at different locations to measure a variety of stream characteristics. In particular, stream gages measure the height of the stream flow, stage, and stream velocity.



A typical stream gage.

The U.S. Geological Survey maintains nearly 7,000 stream gages around the United States. The data from these sites can be readily obtained from their Web site and is invaluable in planning engineering structures along the stream as well as for future floods.

Data

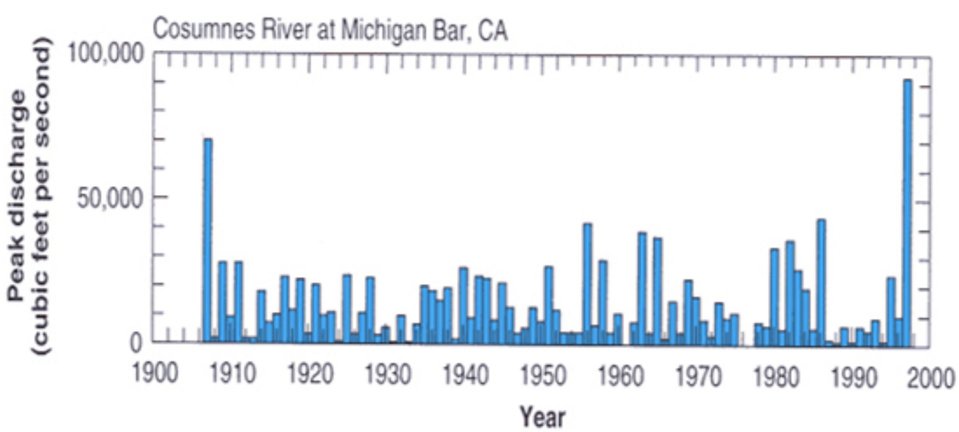
The data supplied by the U.S. Geological Survey for different stream gaging stations includes both directly measured data as well as information calculated from that information (derived characteristics). The direct measurements made at stream gages include:

- channel width
- stream stage (depth)
- stream velocity

Of these data, only stream stage and velocity are dynamic. Stream channel width is generally fixed by may varies as stream height varies. From the stream width and depth (stage), the stream cross-section (A) can be calculated. Knowing the cross-section, the discharge of the stream (Q) is obtained by multiplying it by the stream velocity: (Q = A•v)

Stream Record

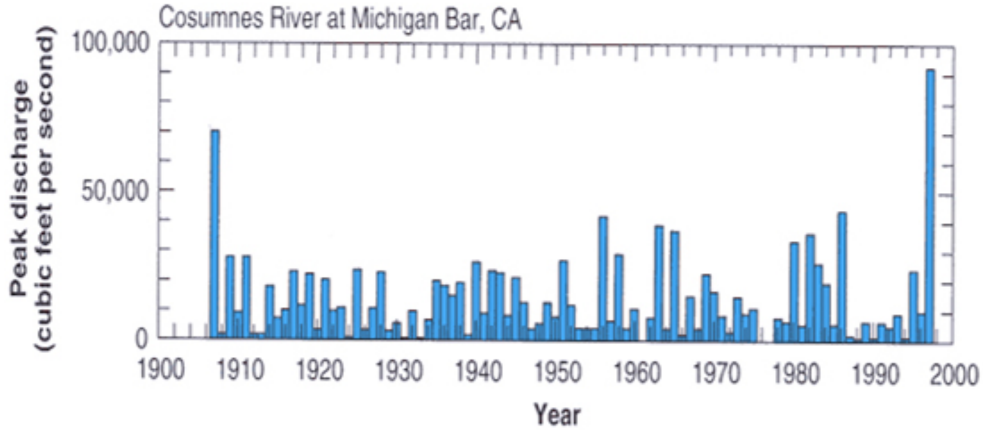
From the daily discharge readings, the maximum annual flood is determined and a stream record complied for the stream.



Stream record showing the peak annual discharge for a particular stream.

Calculating Flood Recurrence Interval

Calculating the flood frequency diagram for a stream always starts with the data derived from the appropriate stream gages. From this wealth of information, a plot of maximum annual peak discharge vs year is constructed. This information is the fundamental basis for calculating flood frequency.



A peak discharge vs year plot is the starting point for calculating flood frequency.

Ranking

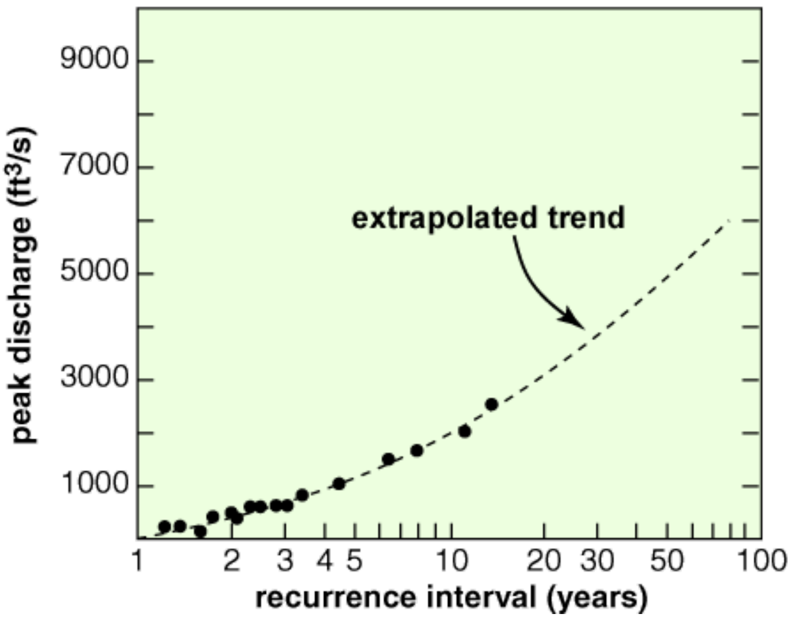
Flood recurrence interval is calculated using historical data summarizes each year's highest discharge. The data for the gage station is ranked in decreasing order of discharge. This assigns each maximum annual flood a ranking, i.e. from 1 the largest to n the smallest where n equals the number of years represented by the records. The recurrence interval for each particular flood rank is calculated from the following equation:

$$\text{recurrence intrval} = \frac{(n + 1)}{m}$$

where n is the number of years represented by the historical record and m is a flood's ranking.

Frequency Curve

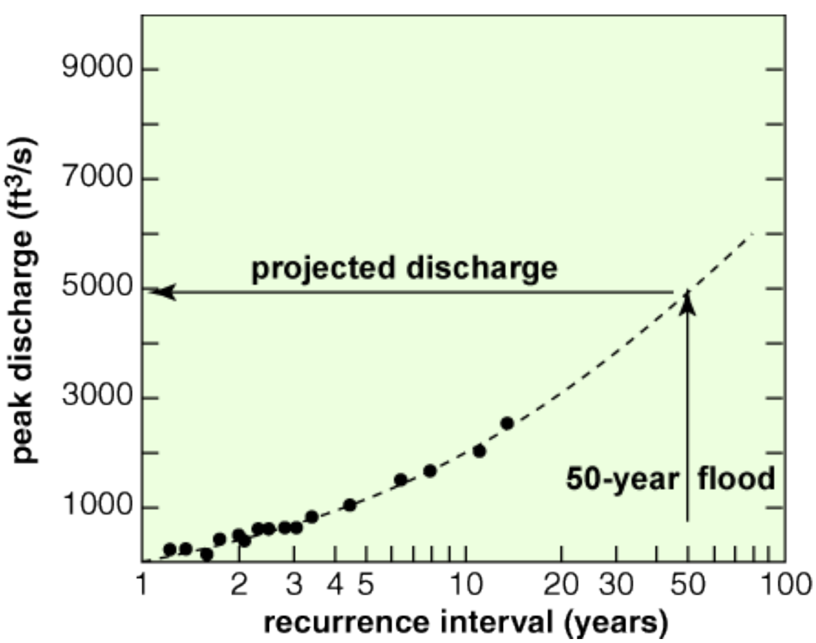
To extrapolate and intrapolate records, recurrence interval is plotted against discharge. To produce a strength line, recurrence interval is plotted on a lograthmic scale on the horizontal axis. The discharge is plotted vertically using a simple linear scale.



The longer the historic record of stream data the more accurate the flood frequency diagram.

Prediction

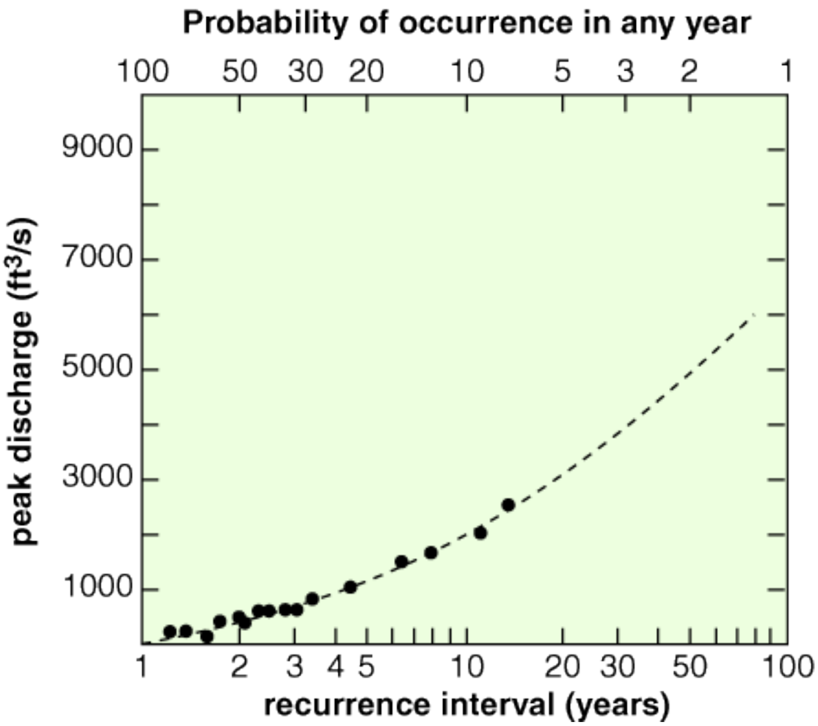
Armed with a flood frequency diagram for a particular stream, it is possible to predict the discharge for a flood of a particular recurrence interval. Knowing the cross-section of the stream and its flood discharge, the equation for discharge ($Q = A \cdot v$) can be solved for velocity and stream stage.



Knowing stream stage is critical in setting the elevation of flood zones for different magnitude floods.

Probablility

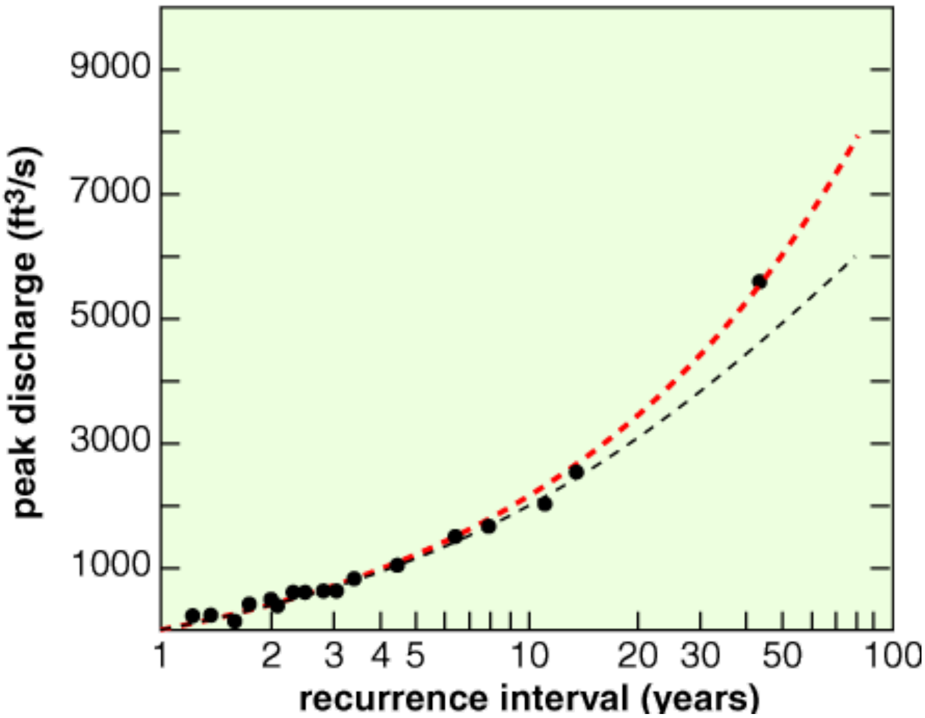
The probability of a flood of rank m occurring in any particular year is simply the reciprocal of the recurrence interval. Thus, a 10-year flood has a probability of 1/10 or 10 % and a 50-year flood has a probability of 2 %.



It is important to remember that the probability of a flood of a particular size occurring in a year is independent of what happened on the stream in the past few years. Thus, the occurrence of a 100-year flood in the preceding year, does not preclude if from the following year. To determine the probability of a flood of a give size occurring two successive years, multiply their percentages for each year together. Thus, the probability of two 100-year floods following each other is 0.01 % (= 0.01•0.01=0.0001).

Record Length

The quality of the recurrence interval prediction is critically dependent upon the historical flow data set used to make it. In particular, the data set must have been collected over a long enough period that it recorded large flooding events.



Because of their frequency, small magnitude events are common in a river's flow data. Thus, there is a large clustering of data points near the origin. In contrast, large floods are rare events. Consequently, there may be only one or two in a river's flow data. This single points have a dramatic effect on the slope of the line put through the data. The graph above shows the effect of including different large flooding events in the data set on the recurrence curve.

Reference:

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