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The 100 Year Flood

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INTRODUCTION

Whenever a flood occurs, the term “100 year flood” is often heard or written in news stories. Frequently, the person citing reference to the “100 year flood” has no idea what he or she is talking about. This educational note has been prepared to explain the specific concept of the 100 year flood, and the general concept of average return period.

DEFINITION

The 100 year flood is the flood which occurs on the average once every 100 years. The key words in the previous sentence are “on the average”. A 100 year flood does not occur once every 100 years.

AVERAGE RETURN PERIOD

When considering the 100 year flood, the time period of 100 years is defined as the average return period. The concept of the average return period is also applicable to floods having different return periods. A 10 year flood has an average return period of 10 years, and occurs on the average once every 10 years.

ILLUSTRATIVE EXAMPLE OF AN AVERAGE RETURN PERIOD

A person you know bought a new car according to following schedule

Year	1989	1999	2003	2009	2016	2019
Elapsed time	----------	10 years	4 years	6 years	7 years	3 years

Over the period from 1989 to 2019, the person bought six new cars. The average return period for purchasing a new was 30/6 = 5 years. Note that none of the values of the elapsed time between new car purchases is equal to 5 years.

The 100 Year Flood (continued)

FLOOD RISK

The risk of a flood occurring is defined in terms of probability. The probability of a particular flood occurring in any given year can be anywhere between 0 and 1, consistent with probability theory. Some specific examples:

A flood that has a 1% chance of occurring during any given year
A flood that has a 10% chance of occurring during any given year
A flood that has a 50% chance of occurring during any given year

The lower the percentage of occurrence, the more severe that the flood will be.

RELATING FLOOD RISK TO AVERAGE RETURN PERIOD

The risk of a flood occurring can be related to the average return period of the flood. The average return period of the flood is calculated as the multiplicative inverse of the risk. For example, the flood that has a 1% risk (probability) of occurring is equivalent to 1 divided by 0.01, being equal to 100. The flood that has a 1% risk of occurring is equivalent to the flood that has an average return period of 100 years.

Risk of a flood occurring during any year	Average return period of the flood
1%	100 years
2%	50 years
4%	25 years
10%	10 years
20%	5 years
50%	2 years

ACTUAL AVERAGE RETURN PERIOD OF A FLOOD

Most of the floods that occur have average return periods that are not exactly equal to average return periods shown in the table above. The actual average return periods will be numbers like 15.6 years, 3.9 years and 86.1 years. Determining the actual average return period is a complex process involving statistical analysis of stream flow data, precipitation depth and precipitation temporal patterns. A politician, safety director, fire chief and news reporter ordinarily have not done the statistical analysis required to report the average return period of a flood with any degree of accuracy. If you notice a person bantering the term “100 year flood”, there is high probability that it was not the “100 year flood”.

The 100 Year Flood (continued)

INTERESTING TRIVIA ABOUT FLOOD RISK

If you are mathematically inclined, the following equation, based on the binomial theorem can be used to predict the risk of a flood occurring at least once over a certain number of years.

$$R = 1 - \left(1 - \frac{1}{T_R}\right)^n = 1 - [1 - p]^n$$

Where R = risk of a flood occurring at least once over a period of n years.

T_R = average return period of the flood in years

p = probability of the flood occurring in any one year. Note $T_R = 1/p$.

Examples:

Determine the risk that the 100 year flood will occur at least once over the next 25 years.

T_R = 100 years, p = 1/100 = 0.01, n = 25 Answer: R = 0.22

Determine the risk that the 10 year flood will occur at least once over the next 8 years.

T_R = 10 years, p = 1/10 = 0.1, n = 8 Answer: R = 0.57