Overview

Introduction

Frequency analysis of floods is a statistical method used in hydrology to estimate the probability of occurrence of extreme flow events, such as floods, over a given period. It is typically based on the study of observed annual maximum flood discharges over several years. An alternative approach is the peak over threshold (POT) method, which considers all flood peaks that exceed a certain threshold, rather than only the annual maxima. This method allows for a more detailed analysis of extreme flood events by using more data points above the chosen threshold.

The objective is to determine the discharge associated with a return period, that is, the discharge that has a certain probability (e.g., 1%, 10%) of being exceeded in any given year. For example, a 100-year flood has a 1% chance of being exceeded in any year.

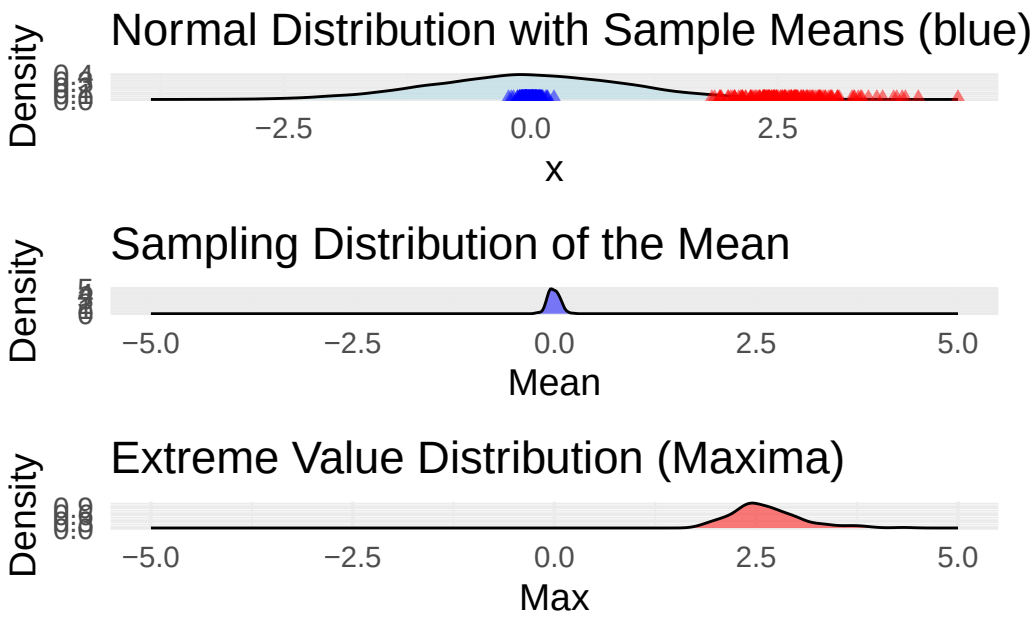
To achieve this, the data are fitted to a probability distribution (such as the Gumbel distribution), and a frequency curve is constructed linking discharges to return periods. This curve is then used to design hydraulic structures (dams, bridges, levees) and to manage flood risks.

Frequency analysis thus allows for an objective assessment of flood-related risks and supports informed decision-making in land-use planning and flood protection.

Extreme Value Theory (EVT)

Imagine we have daily observational data for a random variable (e.g., river discharges, precipitations, etc.) for many years. EVT suggests that the extreme values of this variable are asymptotically close to one of three types of extreme value distributions, regardless of the original distribution of daily flows.

The EVD helps us estimate the probability of rare, high-flow events like floods.


Normal Distribution with Sample Means (blue)
Density
−2.5
0.0
2.5
x
Sampling Distribution of the Mean
Density
−5.0
−2.5
0.0
2.5
5.0
Mean
Extreme Value Distribution (Maxima)
Density
−5.0
−2.5
0.0
2.5
5.0
Max