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Universität Potsdam

Climate Data Collection and Analysis Workshop

February 27, 2024

Today's Schedule

Day 2: Designing, Building, and Analyzing Data from Open-Source Sensors

09:30 – 10:00 Moving towards High-Frequency Data

10:00 – 10:30 Potential of Low-Cost Hardware to Improve Environmental Monitoring

10:30 – 10:45 Tea/Coffee Break

10:45 – 11:15 Designing and Building a Low-Cost River Monitoring Station

11:15 – 12:30 Practical Example – Collecting, Transmitting, and Processing High-Frequency Data

12:30 – 13:30 Lunch Break

13:30 – 14:00 Construction of a Low-Cost Weather Station

14:00 – 14:45 Practical Example – Combining Sensor and Satellite Data for Further Analysis

14:45 – 15:00 Tea/Coffee Break

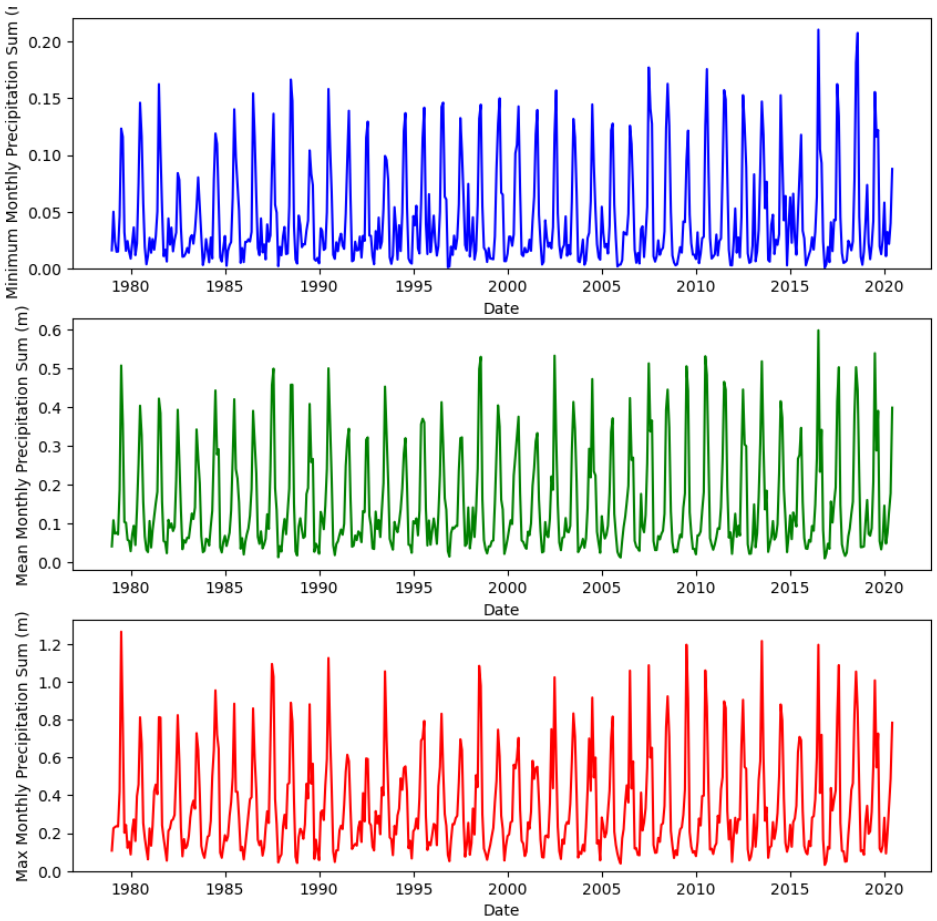
15:00 – 15:45 Research Outlook and Practical Applications in Nepal

15:45 – 16:00 Wrap Up and Further Resources

What is High Frequency Data?

The precipitation data we worked with has **500 values** to cover 45 years!

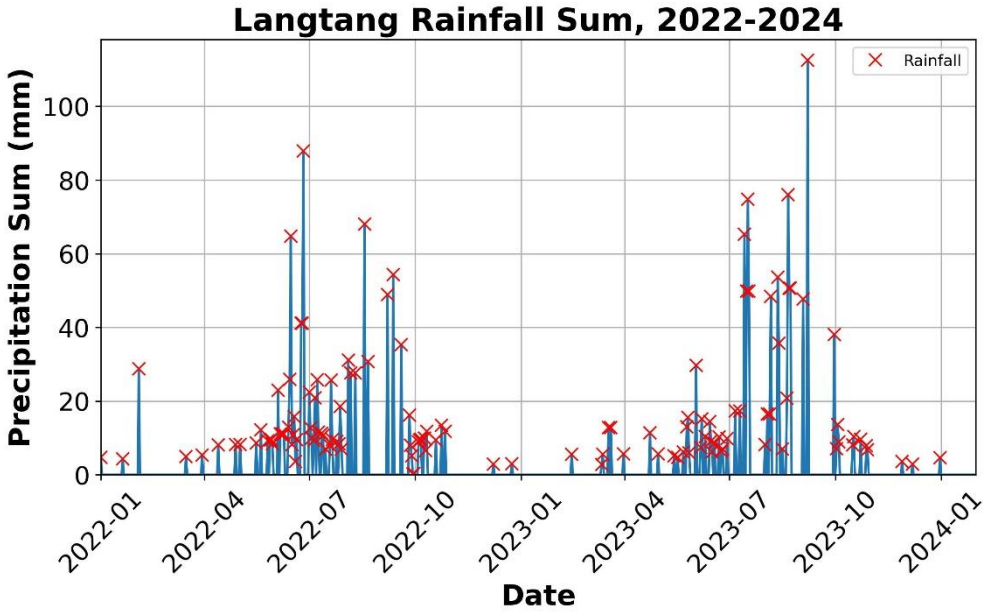
This is better than **annual or decadal data**, which is common in some climate data (for example, temperature for the past 1000 years)



What is High Frequency Data?

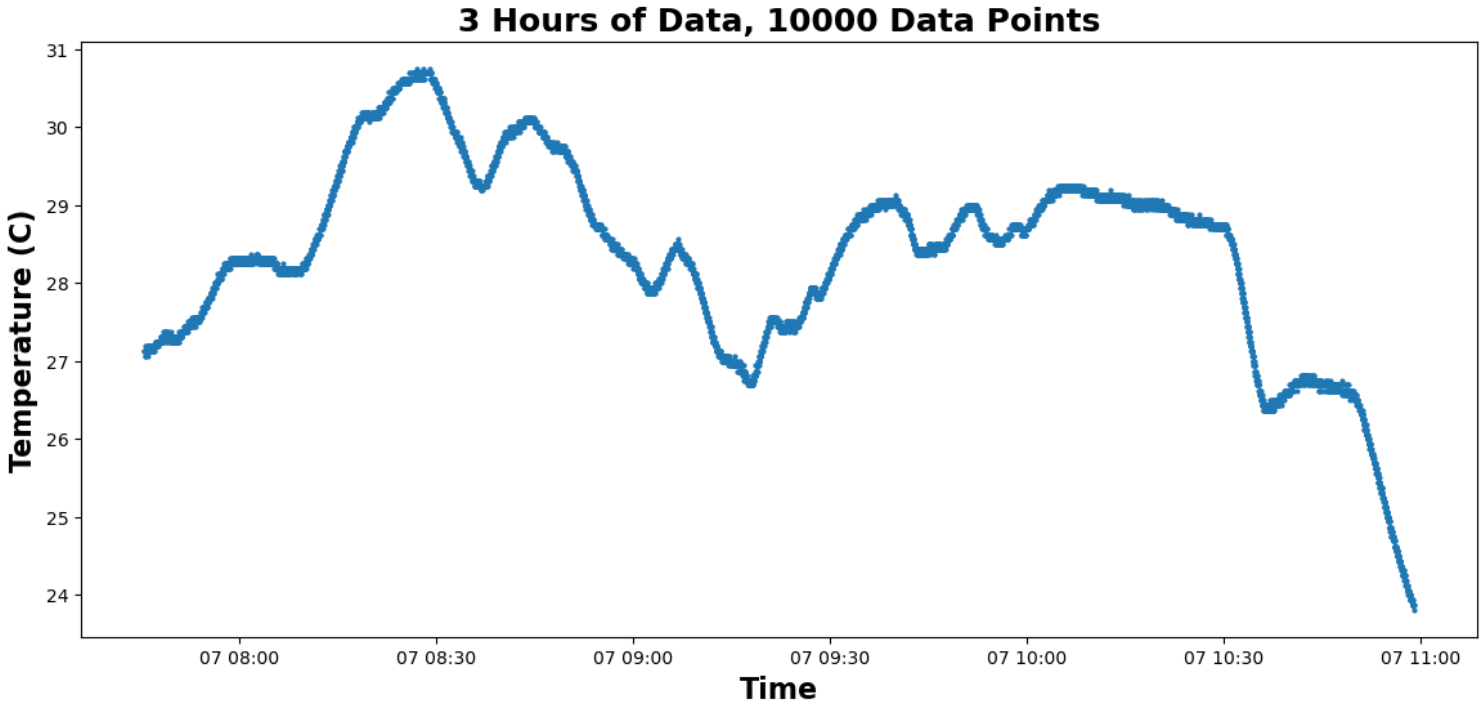
Daily precipitation is again higher frequency, but still would miss very short events

In some applications this would be considered very high frequency, and in others it is still too coarse

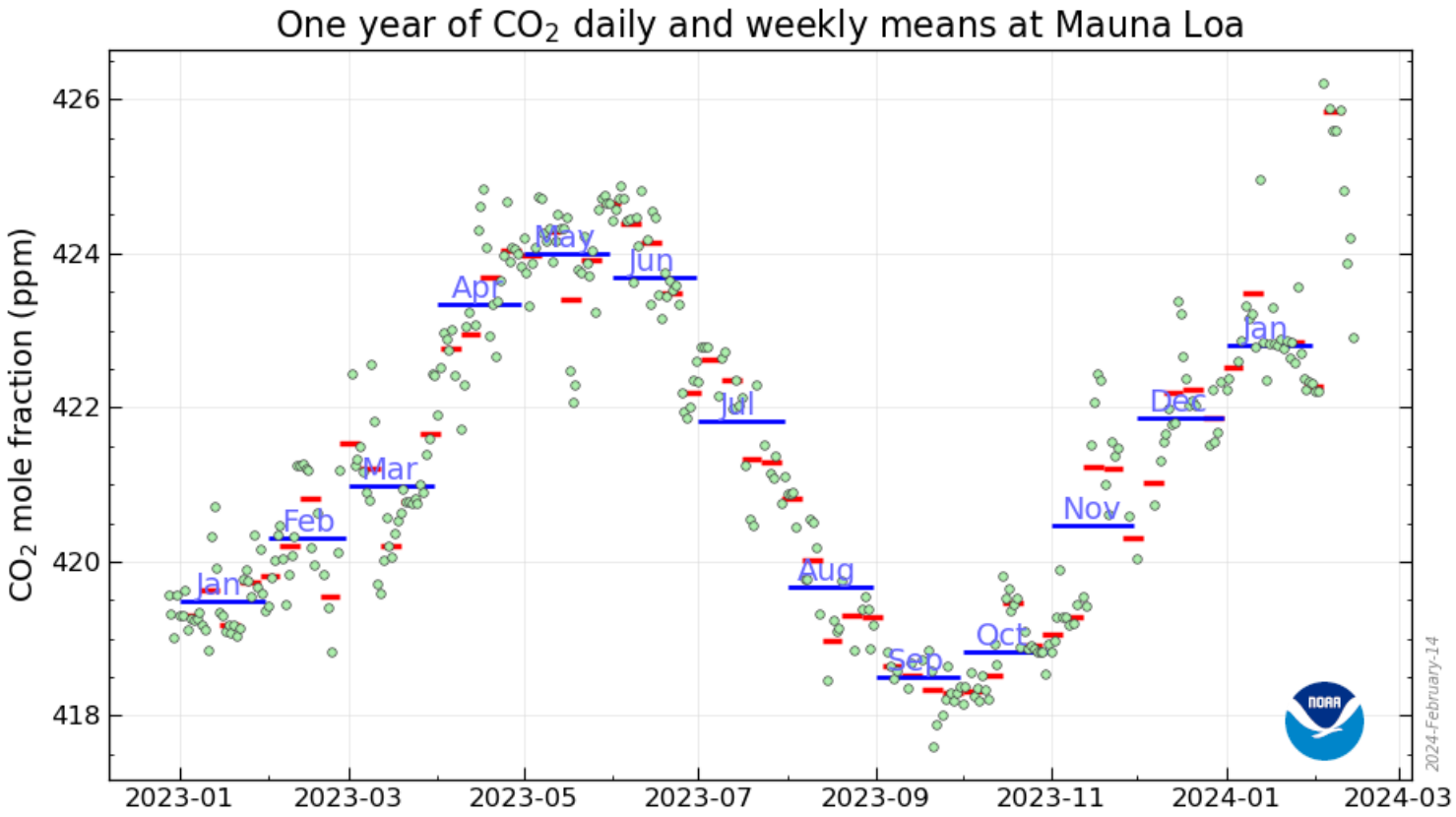


What is High Frequency Data?

There is no one standard definition for high-frequency data – it depends on the time scale of the process you are measuring



Why is high frequency data useful?

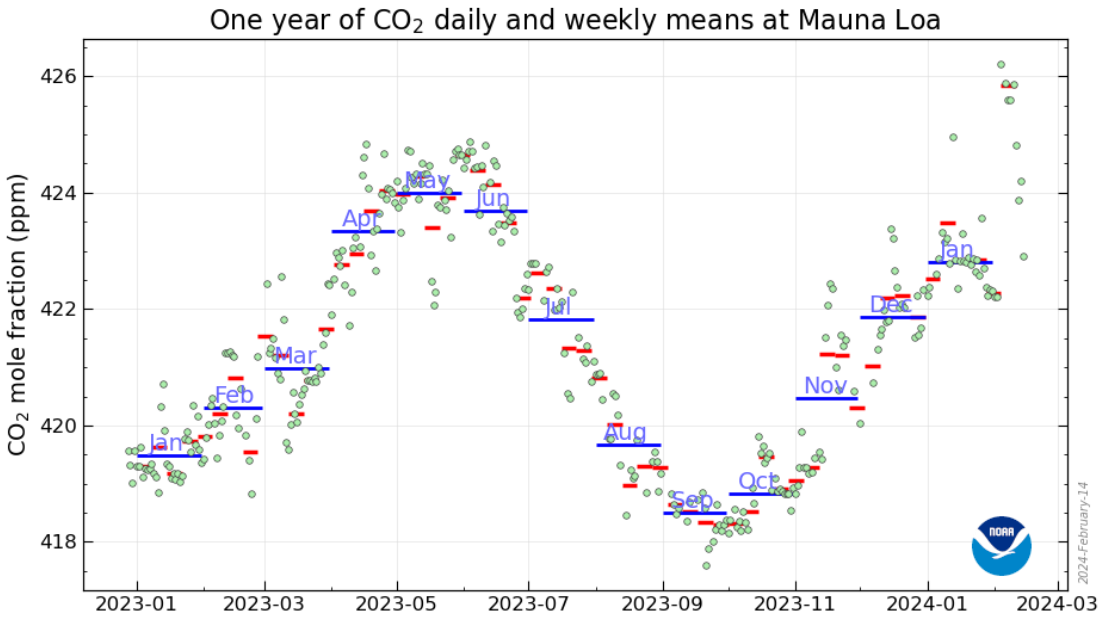


Via: https://gml.noaa.gov/ccgg/trends/weekly.html

Why is high frequency data useful?

Averages over longer time periods (months, years) give *more stable values*

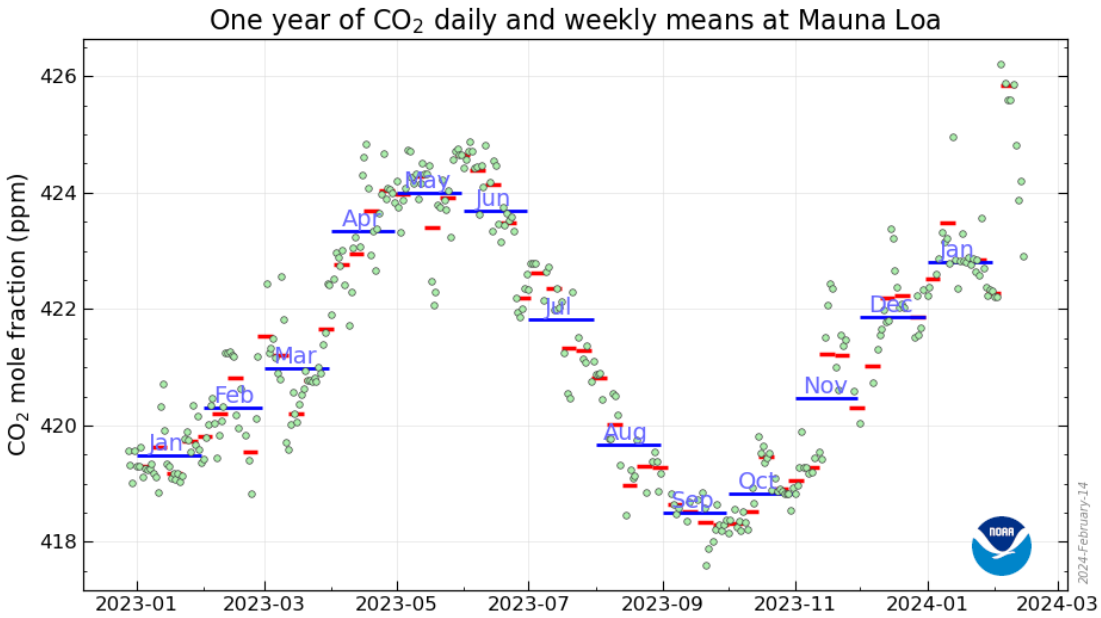
These data are much better for looking at *trends*



Why is high frequency data useful?

The high-frequency data is more useful for *tracking short term changes*

This is very important for monitoring *extreme events*

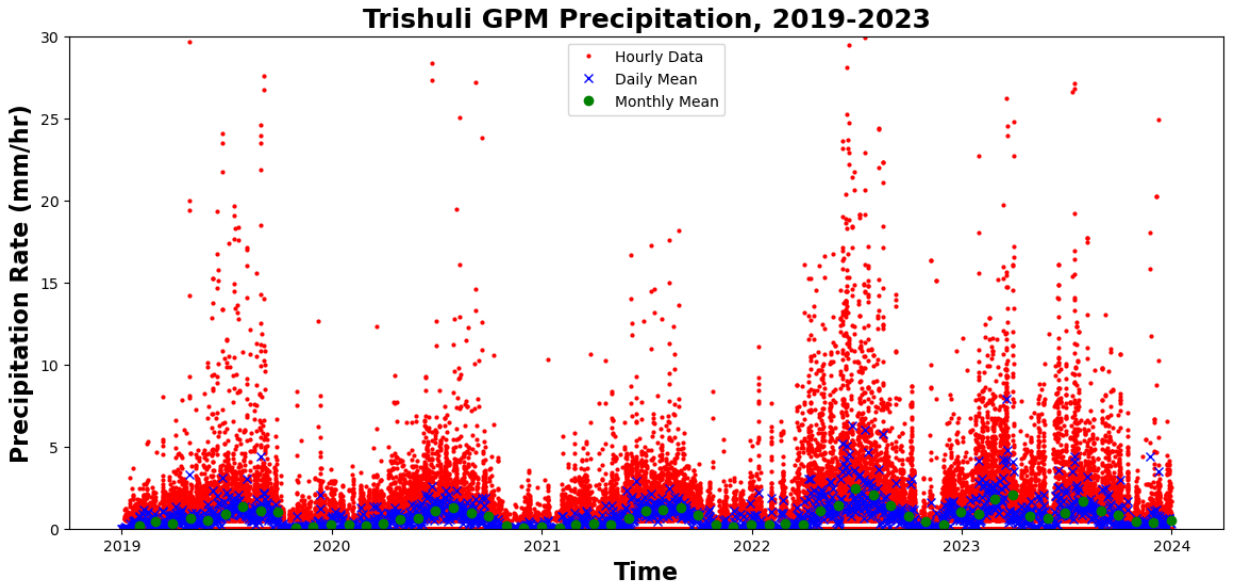


Focus on Extreme Events

Many natural disasters happen quickly – floods are a very good example of this

In many cases, the *annual average rainfall* during a flood year is normal, but the *timing* is not!

If we look at rainfall data even for five years, the differences in the hourly, daily, and monthly averages become apparent:

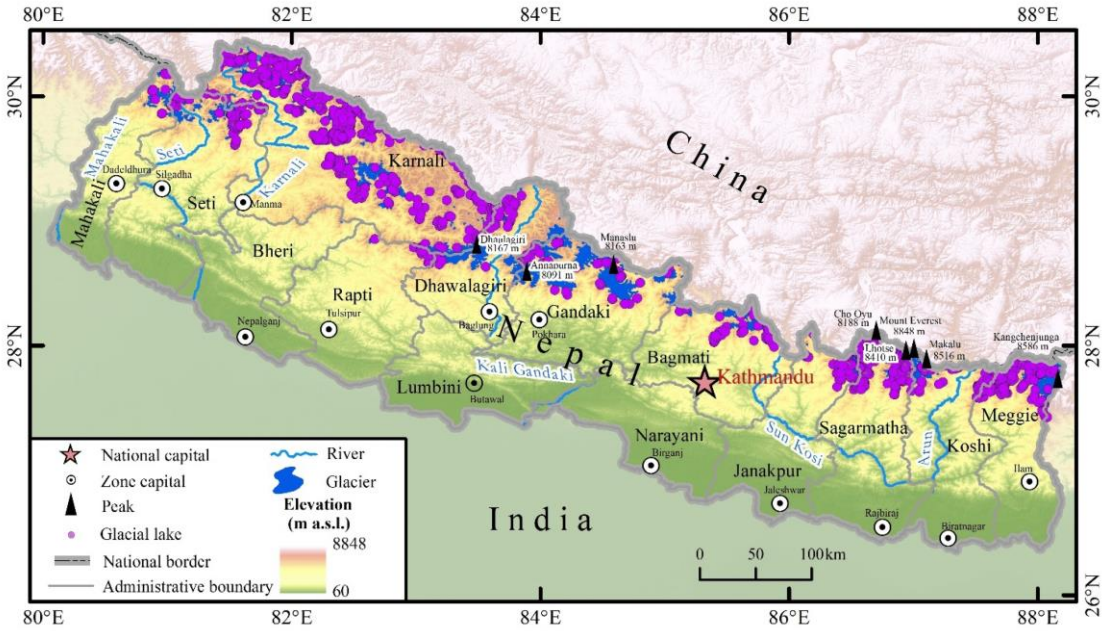


Focus on Extreme Events

One extreme event type that is especially relevant in Nepal is **Glacier Lake Outburst Floods (GLOFs)**

When discharge or other river parameters are measured only once per day (or less), rapid changes are often missed

This makes understanding the **frequency** – and thus the hazard – of these events difficult!



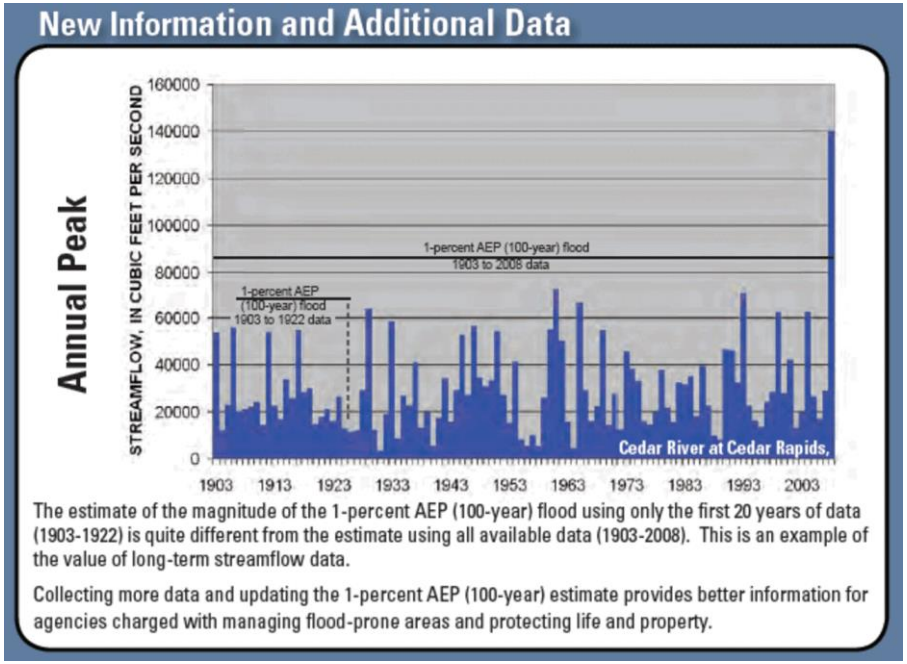
Via: https://www.mdpi.com/2072-4292/14/19/5034

Frequency of Events

In many fields, it is important to know not just the *average* quantity, but how frequently that quantity changes

One easy example is in hydropower – you don't just need to know the average flow to design a system, you also need to know what the peak and minimum flows are

It is also important to know how often you have very high or very low flow – this is what is meant by the **frequency of events**



Via: https://www.usgs.gov/special-topics/water-science-school/science/floods-and-recurrence-intervals

Frequency of Events

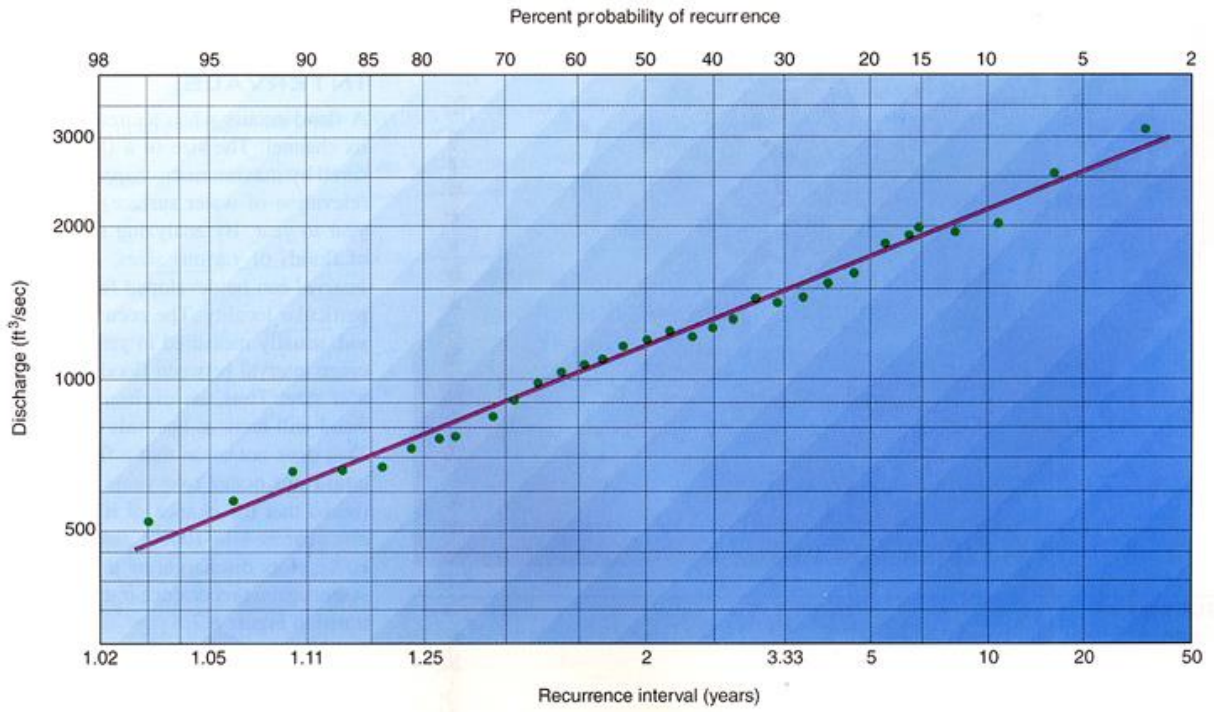
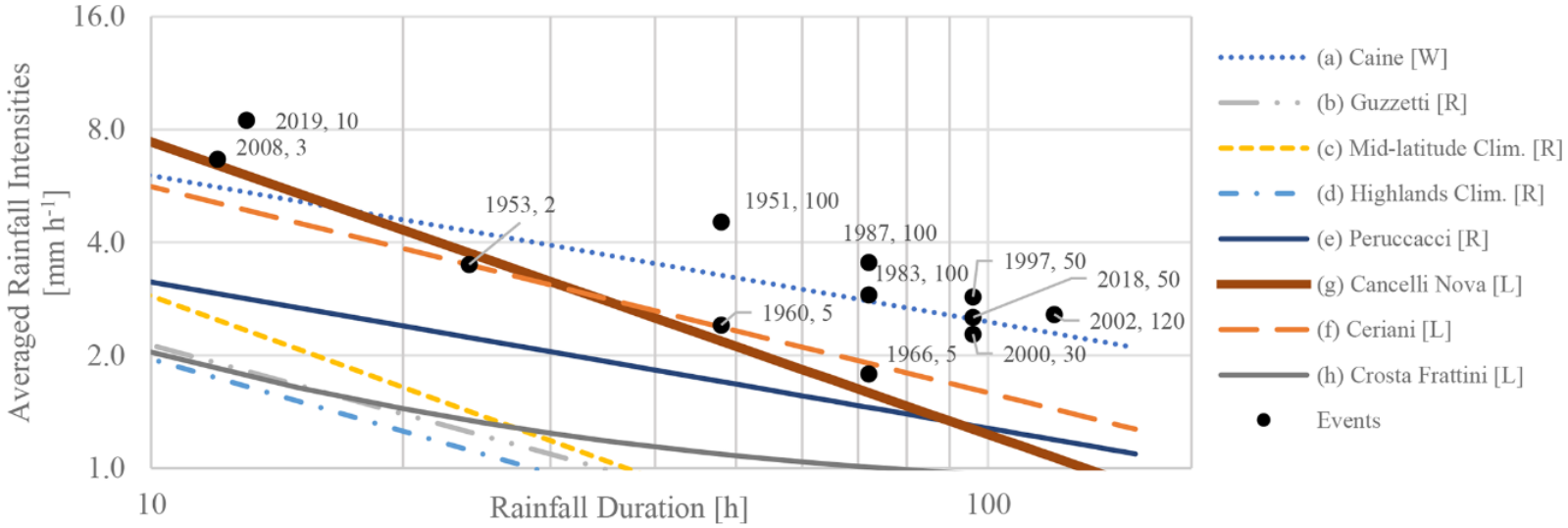


FIGURE 8.7
Flood-frequency curve for Rock Creek near Red Lodge, Montana, 1932 to 1963, using maximum annual discharge data from the USGS. From the *Recurrence Interval* (*RI*) scale (bottom), it can be predicted that, on average, a discharge of 2600 ft³/sec will be attained every 20 years. Using the *Percent Probability of Recurrence* (*P*) scale on top, the same thing can be said in a different way: there is a 5% probability that a discharge of 2600 ft³/sec will be reached in a given year. $P = 100/RI$.

Via: https://www3.nd.edu/~cneal/planetearth/Lab-SurfaceHydrology/Fig8.7.jpg

Frequency of Events



Via: https://nhess.copernicus.org/articles/21/2041/2021/nhess-21-2041-2021.pdf

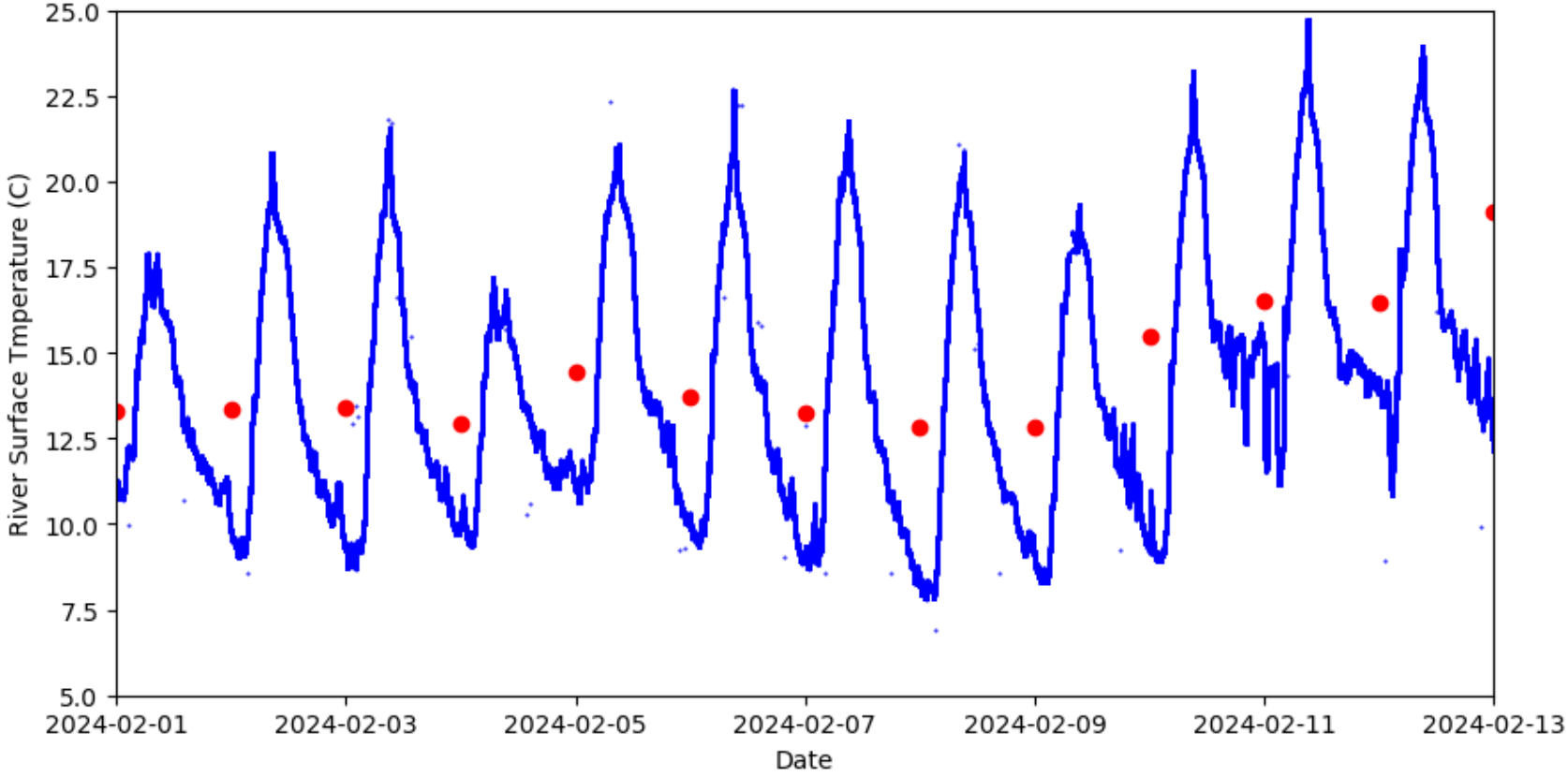
How does High-Frequency Data Help?

If you only use daily discharge data (or daily rainfall, temperature, etc), you can only find **daily extremes** in your record

This does not help to find really fast events – floods that only last for an hour or two are often missed in long data records!

To get a better understanding of short-term extreme events, **it is important to have data at that time scale!**

How does High-Frequency Data Help?



Drawbacks

High-frequency data is more difficult to store (bigger data files)

It requires a different data collection strategy and sometimes different hardware

Processing high-frequency data requires extra processing time and computational power

It is not always necessary to collect high-frequency data!