Rain Data Viewer

User Guide - Rainfall Analysis Tool

Supported by: eThekwini Municipality | ICLEI | University of KwaZulu-Natal | Obscape

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1. Overview

Quick Summary: The Rain Data Viewer analyses historical rainfall records from rain gauges. Upload a CSV file and explore statistics, trends, frequency analysis (IDF curves), and climate indices - all in your browser. No data leaves your device.

This tool processes rainfall time series data to produce comprehensive hydrological analyses typically required for stormwater design, flood risk assessment, and climate studies. All calculations run in your web browser using JavaScript - your data is never uploaded to a server.

2. Data Requirements

Quick Summary: Your CSV needs a Unix timestamp column, a time string column, and a rainfall column (mm). Optional header lines starting with # can provide station metadata.

CSV Format

The tool expects a CSV file with the following structure:

```
# Station name = My Rain Gauge
# Latitude [deg] = -29.72
# Longitude [deg] = 31.09
#
# timestamp [sec UTC],timestring [local],Rainfall intensity [mm],...
1657270834,2022-07-08 11:00:34,0.000,...
1657281634,2022-07-08 14:00:34,0.500,...
```

Required columns (first three, in order):

Column	Description	Example
1. Timestamp	Unix epoch in seconds (UTC)	1657270834
2. Time string	Human-readable local time	2022-07-08 11:00:34
3. Rainfall	Rainfall amount in millimetres	0.500

Additional columns (battery, temperature, etc.) are ignored. Header lines starting with # are optional but recommended - they provide station name and coordinates for the map display.

Data Quality Notes

- **Record length matters:** IDF analysis and return periods are most reliable with 10+ years of data. Short records produce uncertain estimates.
- **Gaps:** Missing data periods are detected and reported. Large gaps reduce the reliability of trend analysis.
- **Resolution:** The tool works with any recording interval (1-minute, 5-minute, hourly). Finer resolution gives better short-duration IDF estimates.

3. Loading Data

Quick Summary: Click "Choose File" to upload your CSV, or click "Load sample data" to try the tool with a bundled example dataset.

Two ways to load data:

- **Upload your own CSV:** Click the file input button, select your CSV file. The tool parses it instantly in your browser.
- **Sample data:** Click "Load sample data" to load a pre-bundled dataset (Bronze Beach rain gauge, ~18,000 records from 2022-2025). This is useful for exploring the tool before using your own data.

Once loaded, the station name and record count appear next to the file input. The Data tab activates automatically showing a time series chart and station information.

4. Data Tab

Quick Summary: Shows station metadata, a location map, and the complete rainfall time series.

- **Station Information:** Name, coordinates, device type, record period, total records, and any detected data gaps.
- **Location Map:** An OpenStreetMap view centred on the station coordinates (if provided in the CSV header).
- **Time Series Chart:** Interactive Plotly chart showing the complete rainfall record. Use the toolbar to zoom, pan, and export images.

5. Statistics Tab

Quick Summary: Comprehensive rainfall statistics including totals, averages, percentiles, dry/wet spell analysis, and distribution fitting.

Click **"Run Analysis"** to compute statistics. Results include:

- **Basic statistics:** Total rainfall, daily/monthly/annual averages, maximum daily rainfall, percentiles (25th, 50th, 75th, 90th, 95th, 99th).
- **Wet/dry analysis:** Number of rainy days (≥ 0.2mm), dry days, longest wet spell, longest dry spell, percentage of wet days.
- **Distribution fitting:** Gamma and Weibull distributions fitted to the daily rainfall data using the Method of Moments.

Technical detail: Distribution fitting uses the Method of Moments rather than Maximum Likelihood Estimation (MLE). This is computationally simpler for browser-based analysis and produces comparable results for typical rainfall datasets.

6. Trends Tab

Quick Summary: Analyses whether rainfall is increasing or decreasing over time using the Mann-Kendall trend test and Sen's slope estimator.

Four charts are produced:

- **Annual Rainfall:** Total rainfall per year with a linear trend line.
- **Monthly Rainfall:** Average rainfall by month (seasonality). Identifies wet and dry seasons.
- **Moving Average:** 12-month rolling mean to smooth out short-term variability.
- **Heavy Rain Days:** Annual count of days exceeding the 95th percentile threshold.

Technical detail: The Mann-Kendall test is a non-parametric test for monotonic trends. It does not assume the data follows any particular distribution. Sen's slope gives the median rate of change (mm/year). A p-value < 0.05 indicates a statistically significant trend.

7. Frequency Tab (IDF Analysis)

Quick Summary: Produces Intensity-Duration-Frequency (IDF) tables and curves used for stormwater design. Shows how intense rainfall events are expected to be for different durations and return periods.

What is IDF?

An IDF table answers: "For a given storm duration (e.g., 30 minutes) and return period (e.g., 1-in-50 years), what rainfall intensity should I design for?" This is fundamental to stormwater infrastructure design.

How it works

1. **Annual maxima extraction:** For each duration (5, 10, 15, 30, 60 min, 2h, 6h, 12h, 24h), the tool finds the maximum rainfall total in each calendar year.

2. **Distribution fitting:** A Gumbel (Type I Extreme Value) distribution is fitted to the annual maxima series for each duration.

3. **Return period estimation:** The fitted distribution estimates rainfall intensities for return periods of 2, 5, 10, 25, 50, and 100 years.

4. **Confidence intervals:** 95% confidence bounds are computed to indicate uncertainty in the estimates.

Reading the IDF Table

Duration	2-yr (mm)	5-yr (mm)	10-yr (mm)	25-yr (mm)	50-yr (mm)	100-yr (mm)
5 min	8.2	11.5	13.8	16.7	18.9	21.1
30 min	22.4	31.2	37.1	44.8	50.6	56.3
60 min	30.1	42.0	50.0	60.5	68.3	76.1

Example: A 1-in-50 year, 30-minute storm is expected to produce approximately 50.6mm of rainfall. This means there is a 2% chance of this intensity being exceeded in any given year.

Goodness of Fit

The tool reports a Kolmogorov-Smirnov (K-S) test for each duration. A p-value > 0.05 indicates the Gumbel distribution is a reasonable fit. Low p-values suggest the distribution may not be appropriate - treat those estimates with caution.

Technical detail: The Gumbel distribution is fitted using the Method of Moments. This is the standard approach for rainfall frequency analysis in South Africa (e.g., TR102).

8. Climate Tab

Quick Summary: Climate indices that describe rainfall patterns over time - useful for drought monitoring and understanding seasonal concentration.

Standardized Precipitation Index (SPI)

The SPI measures how unusual a period's rainfall is compared to the historical record. Three time scales are computed:

Index	What it shows	Use case
SPI-1	Monthly rainfall anomaly	Short-term drought/wet monitoring
SPI-3	3-month rolling anomaly	Seasonal drought assessment
SPI-12	12-month rolling anomaly	Long-term drought/wet periods

SPI values: > +2.0 = extremely wet, +1.0 to +2.0 = moderately wet, -1.0 to +1.0 = near normal, -2.0 to -1.0 = moderately dry, < -2.0 = extremely dry.

Precipitation Concentration Index (PCI)

- **PCI < 10:** Uniform distribution - rainfall spread evenly throughout the year.
- **PCI 11-15:** Moderate concentration - some seasonal variation.
- **PCI 16-20:** Irregular distribution - distinct wet and dry seasons.
- **PCI > 20:** Strongly irregular - rainfall concentrated in a few months.

9. PDF Report

Quick Summary: Click "Generate PDF Report" to produce a comprehensive downloadable report containing all analyses, charts, tables, and methodology notes.

The generated PDF includes approximately 28 pages covering: executive summary, data overview, methodology, basic statistics, trends, seasonality, threshold exceedance, IDF tables with confidence intervals, significant events, climate indices, limitations, references, glossary, and contact information.

The report is generated entirely in your browser and downloaded as a PDF file. No data is sent to any server.

10. Tips & Troubleshooting

- **File too large?** The tool handles files up to ~50MB comfortably in modern browsers. Very large files (100MB+) may be slow.
- **Wrong format?** The tool expects Obscape-format CSVs. If your data uses a different format, restructure it to match: Unix timestamp, time string, rainfall (mm) as the first three columns.
- **Short records?** IDF analysis with less than 10 years of data will produce wide confidence intervals. Use results cautiously.
- **Charts not rendering?** Try clicking the tab again to trigger a resize, or refresh the page.
- **IDF doesn't match design standards?** This tool uses a simplified Gumbel fit. For critical infrastructure, cross-check against published regional IDF data (e.g., SAWS or DWS tables).