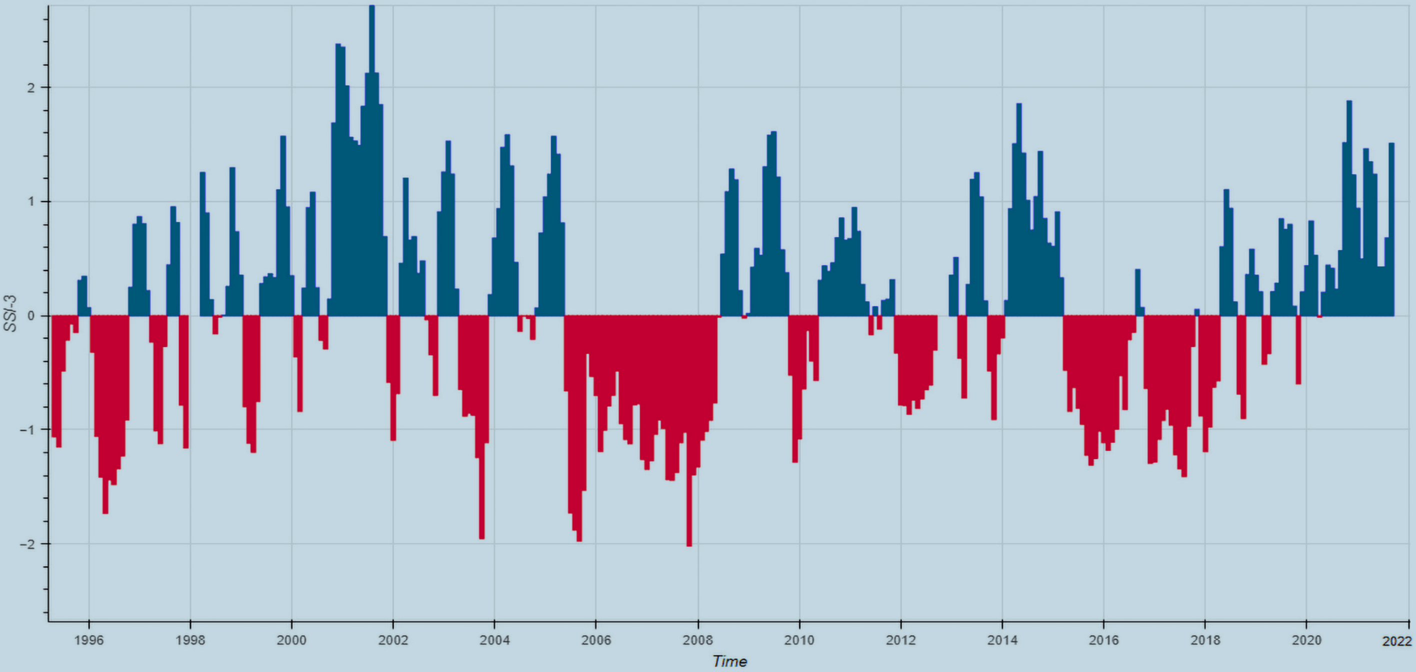
Interreg
Alpine Space
Alpine Drought Observatory



Example of SSI-3 for station ADO_DSC_ITH2_0035 in Italy – Vò Destro (Adige river) based on a 3-monthly rolling window sum

SSI

Standardised Streamflow Index

The Standardised Streamflow Index (SSI, also called SSFI) follows the theoretical concept of the standardised precipitation index (SPI) but is based on monthly streamflow. The SSI can be computed at different time scales, where monthly streamflow is aggregated over a period of time. It allows accurate spatial and temporal comparisons of the hydrological conditions of a stream or a set of streams (Telesca, 2011).

Input variable	Type of drought	Temporal resolution	Temporal coverage	Time scale (aggregation period)	Unit
Monthly streamflow	Hydrological	Monthly	Variable (station dependent), available from streamflow records	1 month (SSI-1) 3 months (SSI-3) 6 months (SSI-6)	Unitless / SSI unit (unit of standard deviation from the long-term mean)

Definition

The Standardised Streamflow Index is introduced by Modarres in 2007, which is statistically similar to the SPI for meteorological analysis. The SSI is a probability-based index, which is defined as the difference of the streamflow from the mean divided by the standard deviation (Modarres, 2007). It uses the methods of normalisations associated with SPI:

$$SSI_{\tau} = \frac{F_{\nu\tau} - \overline{F_{\tau}}}{\sigma_{\tau}}$$

where ν stands for year and τ stands for the interval within the year. SSI values are classified in the same way as SDI (Streamflow Drought Index).

It is recommended that at least 30 years of data should be used for the calculation of the SSI, since the procedure for estimating the parameters of the probability density function depends on the sample properties and size of the observed flow rate.

Methodology

Data source	Data provider	Index provider	Metadata
Observed monthly streamflow	Multiple data providers (ADO project data - CDB Documentation)	Eurac	Hydrological stations

CALCULATION

To compute SSI, monthly streamflow values are fitted to the general extreme value (GEV) distribution, which was identified as the best distribution function for most of the hydrological stations. It is important to mention that none of the probability distributions were found as best able to fit all streamflow series. Even if the analyses were made by regions or by dimension of the basins, a unique probability distribution for these categories could not be identified.

The dataset is fitted using the fitter library in Python, which returns three parameters (shape, location, scale) using the L-moments method. The Python library standard_precip is used to calculate SSI. It calculates the probability distribution function (PDF) based on the 3-parameters of the GEV distribution, then the cumulative distribution function (CDF) is computed, and lastly, the inverse normal distribution is applied to the CDF to obtain the SSI values. This index is also calculated at different rolling moving windows i.e., time scales of 3, 6, and 12 months, with mean zero and standard deviation one.

To quantify the performance of the GEV distribution at 1-month scale the Kolmogorov-Smirnov (K-S) test was calculated since it allows us to decide whether the streamflow data follows the assumed distribution. You can find these calculations in the generated report for each station.

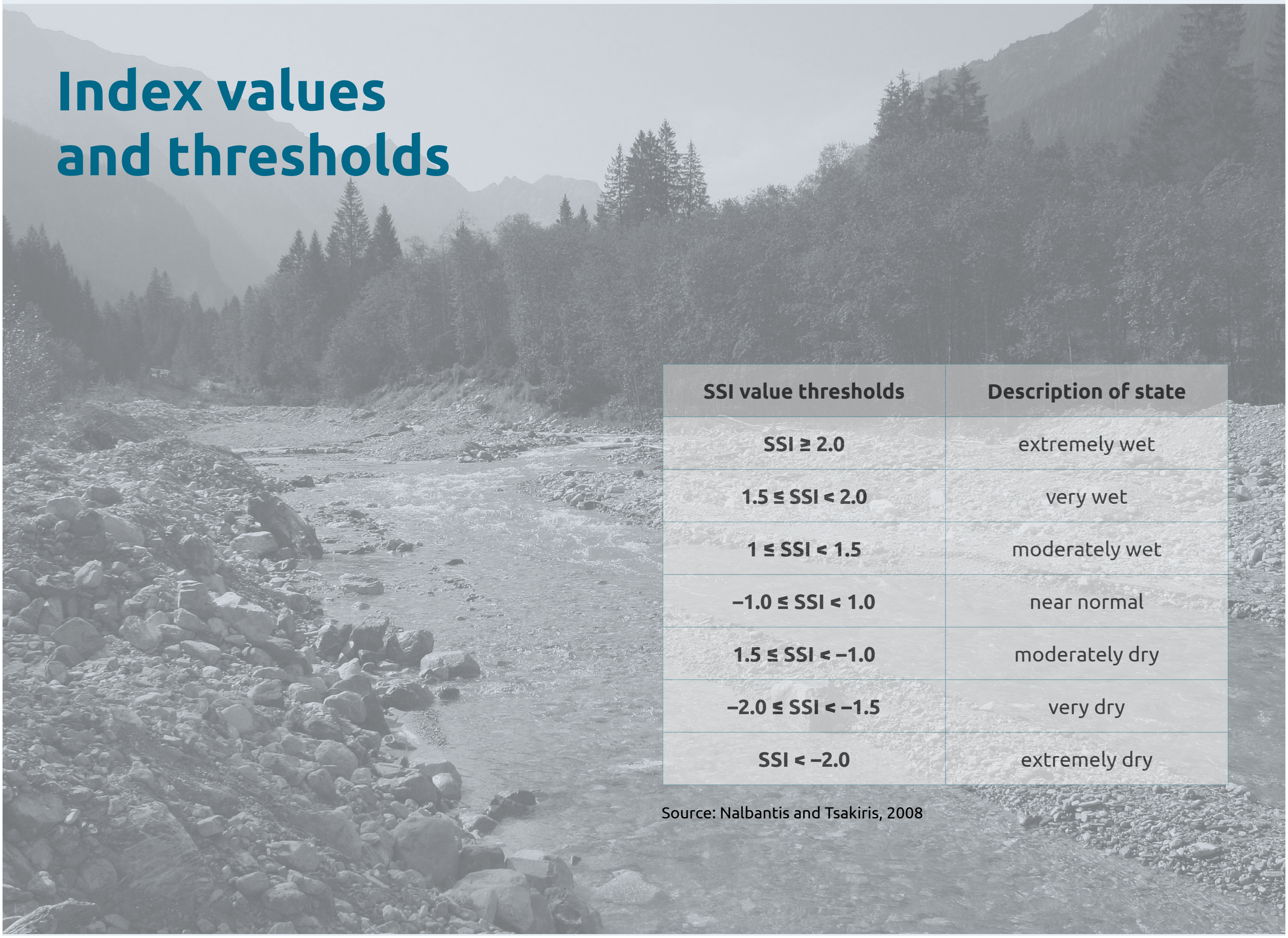
The repository with the calculation of these indices is available at the following link: **ADO / hydrology · GitLab**.

INPUT DATA

The ADO project hydrological database contains observational daily discharge and water level data deriving from the first measurement (which differs for each region) to the present, with more than 1400 stations. These datasets were collected from multiple data providers within the ADO study region, covering the countries Austria, France, Germany, Italy, Slovenia, and Switzerland. The spanned period is 1869–2021. For some regions in Italy there are records to 2022. The missing data were added to have a continuous time series.

REFERENCE PERIOD

For hydrological indices ADO project consortium has recommended to use the entire available time series as reference, which means that the length of the reference period is station dependent.



Index values and thresholds

SSI value thresholds	Description of state
SSI ≥ 2.0	extremely wet
1.5 ≤ SSI < 2.0	very wet
1 ≤ SSI < 1.5	moderately wet
–1.0 ≤ SSI < 1.0	near normal
1.5 ≤ SSI < –1.0	moderately dry
–2.0 ≤ SSI < –1.5	very dry
SSI < –2.0	extremely dry

Source: Nalbantis and Tsakiris, 2008

Key strengths and weaknesses

+ Uses a single variable as input.
+ Allows accurate spatial and temporal comparison between hydrological stations.

− Only accounts for drought monitoring at the streamflow level.

Similarities and differences between SDI and SSI

= Based on the same equation.

= Data is transformed into z-scores.

= Based on the same drought classification scale.

≠ SDI is easier to calculate.

≠ SSI is more robust.

≠ SSI is more sensitive to the aspects that regulate probabilistic hydrology.

References

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