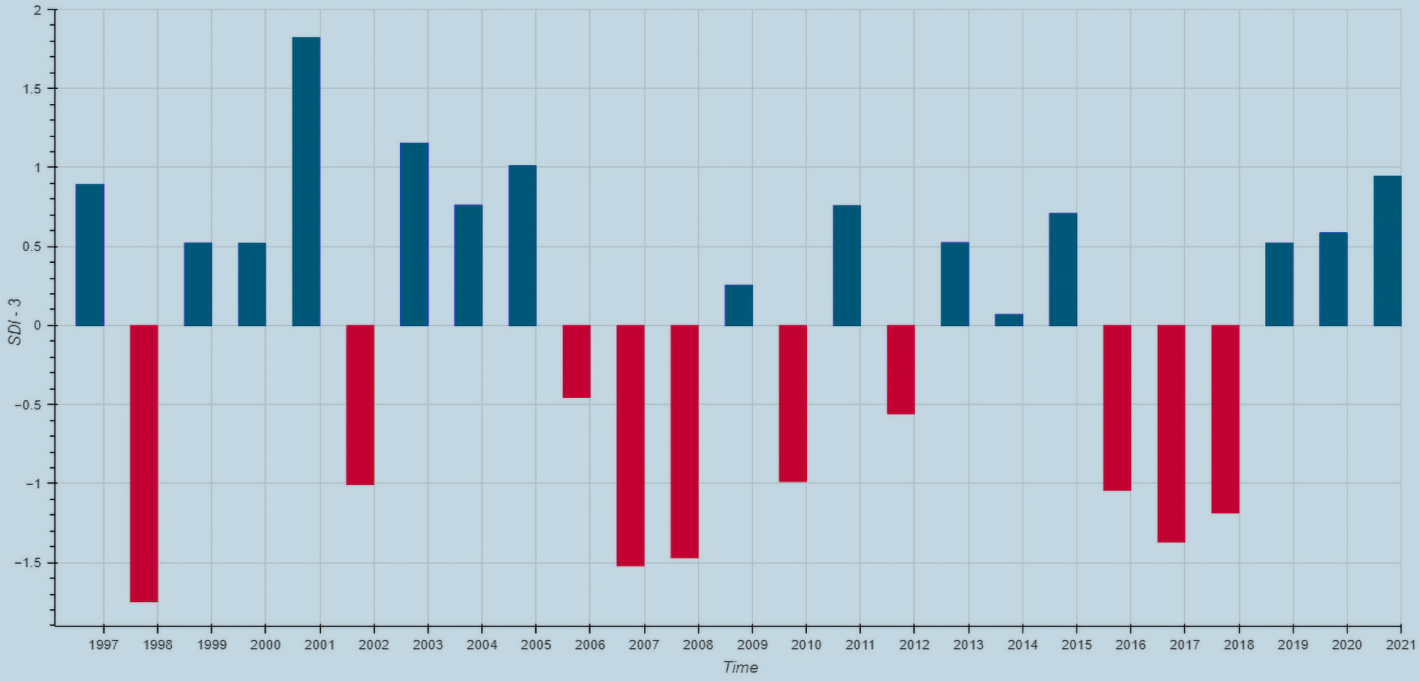
Interreg
Alpine Space
EUROPEAN UNION

Alpine Drought Observatory



Example of SDI-3 for station ADO_DSC_ITH2_0035 in Italy – Vò Destro (Adige river) for the last quarter of the year (July–September)

SDI

Streamflow Drought Index

The Streamflow Drought Index (SDI) has been developed by Nalbantis and Tsakiris. Hydrological drought is defined as a significant decrease in the availability of water for a sustained period compared to normal conditions. In order to evaluate hydrological drought periods, it uses observed monthly streamflow data. The SDI follows the basic concept of the standardised precipitation index (SPI) and can be computed at different time scales, where monthly streamflow is aggregated over a period (1 month, 3 months, 6 months, 9 months and 12 months).

Input variable	Type of drought	Temporal resolution	Temporal coverage	Time scale (aggregation period)	Unit
Monthly streamflow	Hydrological	Monthly	Variable (station dependent), duration available from streamflow records	1 month (SDI-1) 3 months (SDI-3) 6 months (SDI-6) 12 months (SDI-12)	Unitless / SDI unit (unit of standard deviation from the long-term mean)

Definition

The Streamflow Drought Index illustrates the frequency and severity of the hydrological droughts based on streamflow data (Nalbantis and Tsakiris, 2008). It measures anomalies based on the mean of the long-term observed streamflow at a given gauge. It is recommended to use at least 30 years of measurements.

Methodology

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

CALCULATION

In the ADO platform, SDI is calculated on four different time scales (1, 3, 6, 12 months). The time scale (accumulation period) corresponds to the length of the time window over which the total discharge is calculated: 1 month for SDI-1, 3 months for SDI-3, which cover the first three months of the hydrological year (Oct-Dec), 6 months for SDI-6, which cover the first semester of the hydrological year, and lastly, 12 months for SDI-12, which cover the whole hydrological year to define drought conditions for each station.

The streamflow data is transformed to reduce the skewness, which means it is transformed into a normal distribution. The SDI values are classified into 8 states. SDI is a cumulative flow rate index, which means it is based on the cumulative streamflow volume for each reference period of k in the i-th hydrological year (Nalbantis and Tsakiris, 2008).

In the equation below, $V_{i,j}$ is the cumulative streamflow volume, i is the hydrological year and j is the month within the hydrological year and k is the reference period. For instance, considering a time scale of 3-months, the reference period would be k=1 for October-December, k=2 for October-March, k=3 for October-June, and k=4 for October-September.

$$V_{i,j} = \sum_{j=1}^{3k} q_{i,j}$$

$$k = 1, 2, 3, 4$$

$$i = 1, 2, 3, 4 \ldots$$

$$j = 1, 2, 3, 4 \ldots 12$$

$$SDI = \frac{V_{i,k} - \bar{V}_k}{\sigma_k}$$

$\overline{V_k}$ and σ_k are the mean and standard deviation of the cumulative streamflow of the reference period estimated over a long time period. Five states are considered to classify hydrological drought denoted by a number ranging from 0 (non-drought) to –4 (extreme drought) (Nalbantis and Tsakiris, 2008).

Streamflow stations may have a skewed probability distribution, therefore, to reduce the skewness of the streamflow it is transformed to the logarithmic form, in this way, the standardisation is computed using the transformed data. Positive SDI values indicate higher than mean streamflow, while negative values indicate lower than mean streamflow.

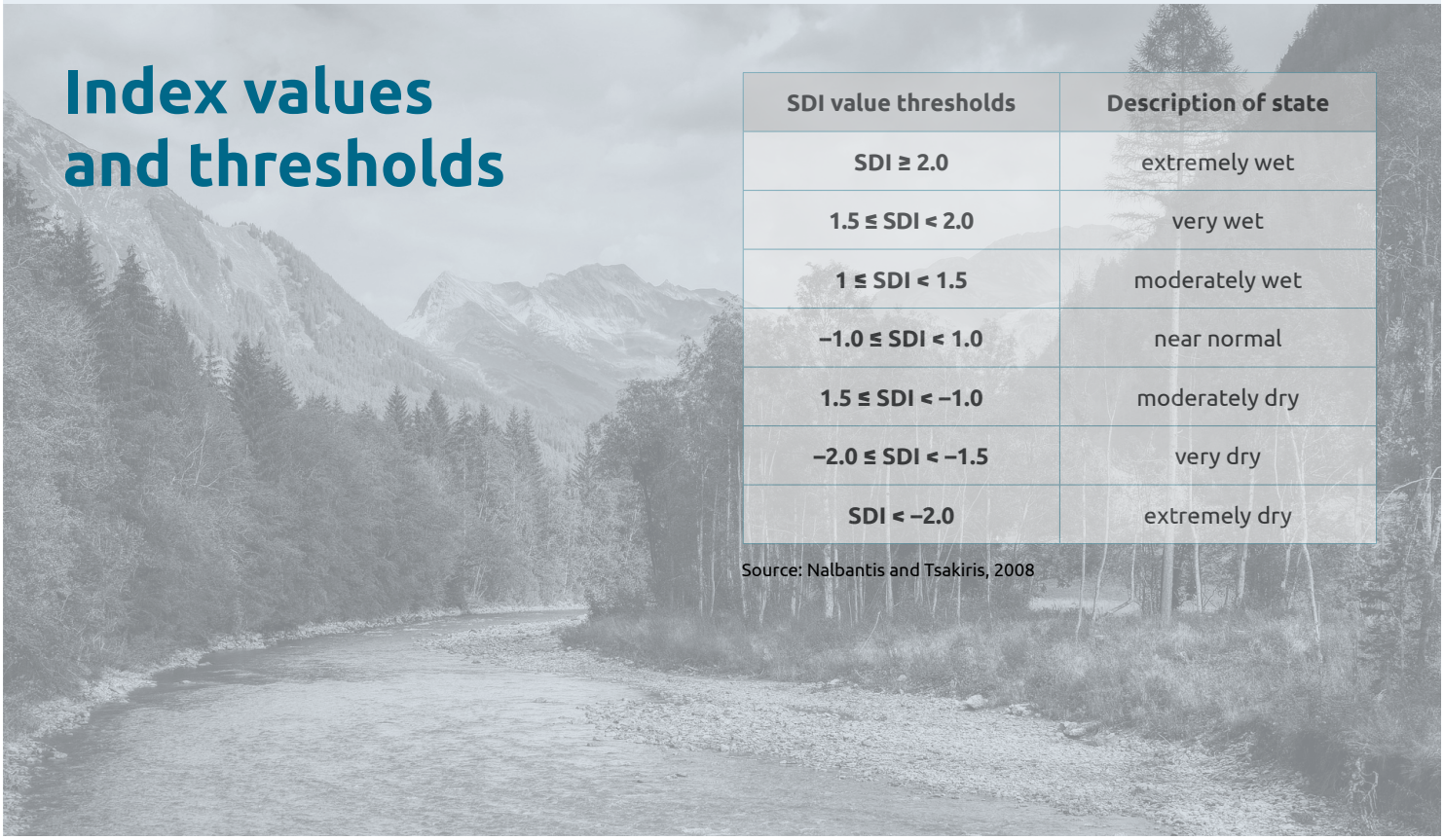
The repository with the calculation of these indices is available at the following link: **ADO / hydrology · GitLab**.

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

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

Source: Nalbantis and Tsakiris, 2008

Key strengths and weaknesses

+ Easy to calculate.
+ The longer the streamflow record, the more accurate the results.

− Does not consider management decisions.
− Periods of no flow can skew the results.

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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