

### Clime Indices of INDECIS and their links to sectorial data (Deliverable 4.2.)

Taking into account the available sectoral data (i.e. agriculture, health, water, tourism, forest, and disaster risk) and the inventory of climatic indices (Deliverable 4.1), we have defined the Indices of INDECIS-ISD, highlighting their utility for the different sectoral data.

### Temperature based indices

1.

ID: GTX

Name: Mean TX

Description: Average value of monthly maximum air temperature

Importance of the index: Important application in agriculture, tourism, human health

Time scale applicable: monthly, seasonal, annual

Geographic limitation: valid for all Europe

Formula: Average value of monthly maximum air temperature.

Reference: Klein Tank AMG, Zwiers FW, Zhang X. 2009. Guidelines on analysis of extremes in a changing climate in support of informed decisions for adaptation, climate data and monitoring WCDMP-No 72, WMO-TD No 1500, p 5.

### 2.

ID: XTX Name: Maximum TX Description: Maximum value of monthly maximum air temperature Importance of the index: Important application in agriculture, tourism, water, human health Time scale applicable: monthly, seasonal, annual Geographic limitation: valid for all Europe Formula: Maximum value of monthly maximum air temperature Reference: Klein Tank AMG, Zwiers FW, Zhang X. 2009. Guidelines on analysis of extremes in a changing

climate in support of informed decisions for adaptation, climate data and monitoring WCDMP-No 72, WMO-TD No 1500, p 5.

### 3.

ID: NTX Name: Minimum TX

Description: Minimum value of monthly maximum air temperature

Importance of the index: Important application in agriculture, tourism, human health

Time scale applicable: monthly, seasonal, annual

Geographic limitation: valid for all Europe

Formula: Minimum value of monthly maximum air temperature

Reference: Klein Tank AMG, Zwiers FW, Zhang X. 2009. Guidelines on analysis of extremes in a changing climate in support of informed decisions for adaptation, climate data and monitoring WCDMP-No 72, WMO-TD No 1500, p 5.







ID: GTN Name: Mean TN

Description: Average value of monthly minimum air temperature

Importance of the index: Important application in agriculture, tourism, human health

Time scale applicable: monthly, seasonal, annual

Geographic limitation: valid for all Europe

Formula: Average value of monthly minimum air temperature

Reference: Klein Tank AMG, Zwiers FW, Zhang X. 2009. Guidelines on analysis of extremes in a changing climate in support of informed decisions for adaptation, climate data and monitoring WCDMP-No 72, WMO-TD No 1500, p 5.

5.

ID: XTN

Name: Maximum TN

Description: Maximum value of monthly minimum air temperature

Importance of the index: Important application in agriculture, tourism, human health

Time scale applicable: monthly, seasonal, annual

Geographic limitation: valid for all Europe

Formula: Maximum value of monthly minimum air temperature

Reference: Klein Tank AMG, Zwiers FW, Zhang X. 2009. Guidelines on analysis of extremes in a changing climate in support of informed decisions for adaptation, climate data and monitoring WCDMP-No 72, WMO-TD No 1500, p 5.

6.

ID: NTN

Name: Minimum TN

Description: Minimum value of monthly maximum air temperature

Importance of the index: Important application in agriculture, tourism, human health

Time scale applicable: monthly, seasonal, annual

Geographic limitation: valid for all Europe

Formula: Minimum value of monthly maximum air temperature

Reference: Klein Tank AMG, Zwiers FW, Zhang X. 2009. Guidelines on analysis of extremes in a changing climate in support of informed decisions for adaptation, climate data and monitoring WCDMP-No 72, WMO-TD No 1500, p 5.

7.

ID: GTG

Name: Mean TG

Description: Average value of monthly mean air temperature

Importance of the index: Important application in agriculture, tourism, human health

Time scale applicable: monthly, seasonal, annual

Geographic limitation: valid for all Europe

Formula: Average value of monthly mean air temperature



Reference: Klein Tank AMG, Zwiers FW, Zhang X. 2009. Guidelines on analysis of extremes in a changing climate in support of informed decisions for adaptation, climate data and monitoring WCDMP-No 72, WMO-TD No 1500, p 5.

8.

ID: XTG Name: Maximum TG Description: Maximum value of monthly mean air temperature Importance of the index: Important application in agriculture, tourism, human health Time scale applicable: monthly, seasonal, annual Geographic limitation: valid for all Europe Formula: Maximum value of monthly mean air temperature Reference: Klein Tank AMG, Zwiers FW, Zhang X. 2009. Guidelines on analysis of extremes in a changing climate in support of informed decisions for adaptation, climate data and monitoring WCDMP-No 72, WMO-TD No 1500, p 5.

9.

ID: NTG Name: Minimum TG Description: Minimum value of monthly mean air temperature Importance of the index: Important application in agriculture, tourism, human health Time scale applicable: monthly, seasonal, annual Geographic limitation: valid for all Europe Formula: Minimum value of monthly mean air temperature Reference: Klein Tank AMG, Zwiers FW, Zhang X. 2009. Guidelines on analysis of extremes in a changing climate in support of informed decisions for adaptation, climate data and monitoring WCDMP-No 72,

WMO-TD No 1500, p 5.

10.

ID: CD

Name: Cold days

Description: Total numbers of days with maximum air temperatures lower than the 10th percentile. Importance of the index: Important application in agriculture, tourism, human health

Time scale applicable: monthly, seasonal, annual

Geographic limitation: valid for all Europe

Formula: No. days TX < 10p

Reference: Klein Tank AMG, Zwiers FW, Zhang X. 2009. Guidelines on analysis of extremes in a changing climate in support of informed decisions for adaptation, climate data and monitoring WCDMP-No 72, WMO-TD No 1500, p 5.

11. ID: CN Name: Cold nights

Description: Total numbers of days with minimum air temperatures lower than the 10th percentile. Importance of the index: Important application in agriculture, tourism, human health Time scale applicable: monthly, seasonal, annual

Geographic limitation: valid for all Europe



Formula: No. days TN < 10p

Reference: Klein Tank AMG, Zwiers FW, Zhang X. 2009. Guidelines on analysis of extremes in a changing climate in support of informed decisions for adaptation, climate data and monitoring WCDMP-No 72, WMO-TD No 1500, p 5.

12.
ID: CDDI
Name: Cold spell duration index
Description: Count of days with at least 6 consecutive days when TN < 10th percentile</li>
Importance of the index: Important application in agriculture, tourism, human health
Time scale applicable: monthly, seasonal, annual
Geographic limitation: valid for all Europe
Formula: 6 consecutive days TN < 10p</li>
Reference: Klein Tank AMG, Zwiers FW, Zhang X. 2009. Guidelines on analysis of extremes in a changing
climate in support of informed decisions for adaptation, climate data and monitoring WCDMP-No 72,
WMO-TD No 1500, p 5.

13.

ID: DTR Name: Diurnal air temperature range Description: Mean difference between TX and TN.

Importance of the index: Important application in agriculture, tourism, human health

Time scale applicable: monthly, seasonal, annual

Geographic limitation: valid for all Europe

Formula: TX-TN

Reference: Klein Tank AMG, Zwiers FW, Zhang X. 2009. Guidelines on analysis of extremes in a changing climate in support of informed decisions for adaptation, climate data and monitoring WCDMP-No 72, WMO-TD No 1500, p 5.

14.
ID: vDTR
Name: vDTR
Description: Mean absolute day-to-day difference in DTR
Importance of the index: Important application in agriculture, tourism, human health
Time scale applicable: monthly, seasonal, annual
Geographic limitation: valid for all Europe
Formula: Mean absolute day-to-day difference in DTR
Reference: Klein Tank AMG, Zwiers FW, Zhang X. 2009. Guidelines on analysis of extremes in a changing
climate in support of informed decisions for adaptation, climate data and monitoring WCDMP-No 72,
WMO-TD No 1500, p 5.



Description: Total number of days with TN < 0°C Importance of the index: Important application in agriculture. Time scale applicable: monthly, seasonal, annual Geographic limitation: valid for all Europe Formula: No. days TN < 0°C Reference: Klein Tank AMG, Zwiers FW, Zhang X. 2009. Guidelines on analysis of extremes in a changing climate in support of informed decisions for adaptation, climate data and monitoring WCDMP-No 72, WMO-TD No 1500, p 5.

16.

ID: GSL

Name: Growing season length

Description: Annual count of days between the first span of at least 6 days with TG >5°C and first span after 1 July of 6 days with TG <5°C .

Importance of the index: Important application in agriculture

Time scale applicable: annual

Geographic limitation: valid for all Europe

Formula: at least 6 days with TG >5°C and first span after 1 July of 6 days with TG <5 °C.

Reference: Klein Tank AMG, Zwiers FW, Zhang X. 2009. Guidelines on analysis of extremes in a changing climate in support of informed decisions for adaptation, climate data and monitoring WCDMP-No 72, WMO-TD No 1500, p 5.

17.

ID: ID Name: Ice days

Description: Number of days with TX <0°C

Importance of the index: Important application in agriculture, tourism, human health

Time scale applicable: monthly, seasonal, annual

Geographic limitation: valid for all Europe

Formula: No. days TX< 0°C

Reference: Klein Tank AMG, Zwiers FW, Zhang X. 2009. Guidelines on analysis of extremes in a changing climate in support of informed decisions for adaptation, climate data and monitoring WCDMP-No 72, WMO-TD No 1500, p 5.

18.

ID: CFD

Name: Maximum number of consecutive frost days (CFD)

Description: Maximum number of consecutive with days TN<0°C

Importance of the index: Important application in agriculture, tourism, human health

Time scale applicable: monthly, seasonal, annual

Geographic limitation: valid for all Europe

Formula: n days with TN <0°C

Reference: Klein Tank AMG, Zwiers FW, Zhang X. 2009. Guidelines on analysis of extremes in a changing climate in support of informed decisions for adaptation, climate data and monitoring WCDMP-No 72, WMO-TD No 1500, p 5.



19.
ID: ETR
Name: Extreme air temperature range
Description: Difference between the highest TX and the lowest TN.
Importance of the index: Important application in agriculture, tourism, human health
Time scale applicable: monthly, seasonal, annual
Geographic limitation: valid for all Europe
Formula: TX<sub>highest</sub>-TN<sub>lowest</sub>

Reference: Klein Tank AMG, Zwiers FW, Zhang X. 2009. Guidelines on analysis of extremes in a changing climate in support of informed decisions for adaptation, climate data and monitoring WCDMP-No 72, WMO-TD No 1500, p 5.

20. ID: SUD Name: Summer days Description: Number of days with TX >25°C. Importance of the index: Important application in agriculture, tourism, human health Time scale applicable: monthly, seasonal, annual Geographic limitation: valid for all Europe Formula: No. days TX < 25°C Reference: Klein Tank AMG, Zwiers FW, Zhang X. 2009. Guidelines on analysis of extremes in a changing climate in support of informed decisions for adaptation, climate data and monitoring WCDMP-No 72, WMO-TD No 1500, p 5.

21.

ID: CSD

Name: Maximum number of consecutive summer days (TX > 25°C)

Description: Maximum number of consecutive days with TX > 25°C

Importance of the index: Important application in agriculture, tourism, human health

Time scale applicable: monthly, seasonal, annual

Geographic limitation: valid for all Europe

Formula: n days with TX >25°C

Reference: Klein Tank AMG, Zwiers FW, Zhang X. 2009. Guidelines on analysis of extremes in a changing climate in support of informed decisions for adaptation, climate data and monitoring WCDMP-No 72, WMO-TD No 1500, p 5.

22. ID: TS Name: Air temperature sums Description: (days TX >17°C)–(days TX <17°C) Importance of the index: Important application in agriculture, tourism, human health Time scale applicable: monthly, seasonal, annual Geographic limitation: valid for all Europe



Formula: (days TX >17°C)–(days TX <17°C)

Reference: Klein Tank AMG, Zwiers FW, Zhang X. 2009. Guidelines on analysis of extremes in a changing climate in support of informed decisions for adaptation, climate data and monitoring WCDMP-No 72, WMO-TD No 1500, p 5.

23.
ID: TN
Name: Tropical nights
Description: Number of days with TN >20°C.
Importance of the index: Important application in agriculture, tourism, human health
Time scale applicable: monthly, seasonal, annual
Geographic limitation: valid for all Europe
Formula: No. days TN >20°C
Reference: Klein Tank AMG, Zwiers FW, Zhang X. 2009. Guidelines on analysis of extremes in a changing
climate in support of informed decisions for adaptation, climate data and monitoring WCDMP-No 72,
WMO-TD No 1500, p 5.

24.

ID: HD17

Name: Heating degree days

Description: (sum(17-TG)) only for days with TG<17°C

Importance of the index: Important application in agriculture, tourism, human health

Time scale applicable: monthly, seasonal, annual

Geographic limitation: valid for all Europe

Formula: (sum(17-TG)) when daily TG<17°C

Reference: Klein Tank AMG, Zwiers FW, Zhang X. 2009. Guidelines on analysis of extremes in a changing climate in support of informed decisions for adaptation, climate data and monitoring WCDMP-No 72, WMO-TD No 1500, p 5.

25.

ID: VCD Name: Very cold days Description: Number of days with TN <1st percentile. Importance of the index: Important application in agriculture, tourism, human health Time scale applicable: monthly, seasonal, annual Geographic limitation: valid for all Europe Formula: No. days TN < 1p Reference: Klein Tank AMG, Zwiers FW, Zhang X. 2009. Guidelines on analysis of extremes in a changing climate in support of informed decisions for adaptation, climate data and monitoring WCDMP-No 72, WMO-TD No 1500, p 5.



# 26. ID: VWD Name: Very warm days Description: Number of days with TX >99th percentile per year. Importance of the index: Important application in agriculture, tourism, human health Time scale applicable: monthly, seasonal, annual Geographic limitation: valid for all Europe Formula: No. days TX > 99p Reference: Klein Tank AMG, Zwiers FW, Zhang X. 2009. Guidelines on analysis of extremes in a changing climate in support of informed decisions for adaptation, climate data and monitoring WCDMP-No 72, WMO-TD No 1500, p 5.

27.

ID: WD Name: Warm days

Description: Total numbers of days with TX higher than the 90th percentile.

Importance of the index: Important application in agriculture, tourism, human health

Time scale applicable: monthly, seasonal, annual

Geographic limitation: valid for all Europe

Formula: No. days TX > 90p

Reference: Klein Tank AMG, Zwiers FW, Zhang X. 2009. Guidelines on analysis of extremes in a changing climate in support of informed decisions for adaptation, climate data and monitoring WCDMP-No 72, WMO-TD No 1500, p 5.

### 28.

ID: WN

Name: Warm nights

Description: Total numbers of days TN higher than the 90th percentile.

Importance of the index: Important application in agriculture, tourism, human health

Time scale applicable: monthly, seasonal, annual

Geographic limitation: valid for all Europe

Formula: No. days TN > 90p

Reference: Klein Tank AMG, Zwiers FW, Zhang X. 2009. Guidelines on analysis of extremes in a changing climate in support of informed decisions for adaptation, climate data and monitoring WCDMP-No 72, WMO-TD No 1500, p 5.

29.

ID: WSD Name: Warm spell duration index

Description: Count of days with at least 6 consecutive days when TX > 90th percentile.

Importance of the index: Important application in agriculture, tourism, human health

Time scale applicable: monthly, seasonal, annual

Geographic limitation: valid for all Europe Formula: at least 6 days with TX >90p



Reference: Klein Tank AMG, Zwiers FW, Zhang X. 2009. Guidelines on analysis of extremes in a changing climate in support of informed decisions for adaptation, climate data and monitoring WCDMP-No 72, WMO-TD No 1500, p 5.

30.
ID: ZCD
Name: zero crossing days
Description: Number of days with TX > 0 °C and TN < 0 °C.</li>
Importance of the index: Important application in agriculture, tourism, human health
Time scale applicable: monthly, seasonal, annual
Geographic limitation: valid for all Europe
Formula: days with TX > 0 °C and TN < 0 °C.</li>
Reference: Klein Tank AMG, Zwiers FW, Zhang X. 2009. Guidelines on analysis of extremes in a changing climate in support of informed decisions for adaptation, climate data and monitoring WCDMP-No 72,

WMO-TD No 1500, p 5.

31.

### ID: OGS6

Name: Onset of growing season 6 days

Description: The start of the first span with at least 6 days with Tmean >5°C

Importance of the index: Important application in agriculture

Time scale applicable: annual

Geographic limitation: valid for all Europe

Formula: The start of the first span with at least 6 days with Tmean >5°C

Reference: Klein Tank AMG, Zwiers FW, Zhang X. 2009. Guidelines on analysis of extremes in a changing climate in support of informed decisions for adaptation, climate data and monitoring WCDMP-No 72, WMO-TD No 1500, p 5.

32.

ID: OGS10 Name: Onset of growing season 10 days Description: The start of the first span with at least 10 days with Tmean >5°C Importance of the index: Important application in agriculture Time scale applicable: annual Geographic limitation: valid for all Europe Formula: The start of the first span with at least 10 days with Tmean >5°C Reference: Klein Tank AMG, Zwiers FW, Zhang X. 2009. Guidelines on analysis of extremes in a changing climate in support of informed decisions for adaptation, climate data and monitoring WCDMP-No 72, WMO-TD No 1500, p 5.



ID: Ta\_o

Name: Growing season air temperature 1

Description: growing season mean temperature (April-October in the Northern Hemisphere; and October-April in the Southern Hemisphere).

Importance of the index: Important application in agriculture

Time scale applicable: annual

Geographic limitation: valid for all Europe

Formula: average of monthly mean temperatures in the growing season (April-October in the Northern Hemisphere; October-April in the Southern Hemisphere).

Reference: Klein Tank AMG, Zwiers FW, Zhang X. 2009. Guidelines on analysis of extremes in a changing climate in support of informed decisions for adaptation, climate data and monitoring WCDMP-No 72, WMO-TD No 1500, p 5.

34.

ID: Tm\_s

Name: Growing season air temperature 2

Description: Growing season (May to September) mean TG

Importance of the index: Important application in agriculture

Time scale applicable: annual

Geographic limitation: valid for all Europe

Formula: mean TG averaged for the period from May to September

Reference: Klein Tank AMG, Zwiers FW, Zhang X. 2009. Guidelines on analysis of extremes in a changing climate in support of informed decisions for adaptation, climate data and monitoring WCDMP-No 72, WMO-TD No 1500, p 5.

35.

ID: GD4

Name: Growing degree days Description: Sum of degree days over 4°C Importance of the index: Important application in agriculture Time scale applicable: monthly, seasonal, annual Geographic limitation: valid for all Europe Formula: Sum of degree days over 4°C

Reference: Klein Tank AMG, Zwiers FW, Zhang X. 2009. Guidelines on analysis of extremes in a changing climate in support of informed decisions for adaptation, climate data and monitoring WCDMP-No 72, WMO-TD No 1500, p 5.

36.
ID: WKI
Name: Winkler index
Description: Sum of degree days over 10°C from April 1 until October 31
Importance of the index: Important application in agriculture
Time scale applicable: Annual
Geographic limitation: valid for all Europe



Formula:  $\sum_{m=Oct}^{Abr} (T_m - 10) * n_m$ ; where n<sub>m</sub> is the number of days, n, of the month, m. All the months with

average temperatures < 10°C are not considered in the sum.

Reference: Winkler, A.J., J.A. Cook, W.M. Kliewer, and L.A. Lider. 1974. General Viticulture. 4th ed. University of California Press, Berkeley.

### 37.

ID: WSI

Name: Winter Severity index

Description: Mean TG of the coldest month of the year

Importance of the index: Important application in agriculture

Time scale applicable: Annual

Geographic limitation: valid for all Europe

Formula: Mean TG of the coldest month of the year

Reference: Klein Tank AMG, Zwiers FW, Zhang X. 2009. Guidelines on analysis of extremes in a changing climate in support of informed decisions for adaptation, climate data and monitoring WCDMP-No 72, WMO-TD No 1500, p 5.

### 38.

ID: STX32

Name: Temperature sums above 32°C (intensity)

Description: Is an agrometeorological parameter characterizing thermal impact on winter wheat and maize crops in Romania. The 32 °C limit is the critical biological threshold for the maximum air temperature from which the physiological optimal growth and development of wheat and maize plants is particularly affected during the critical period with maximum temperature requirements. This critical period corresponds to the June-August interval

Importance of the index: Important application in agriculture, water, human health

Time scale applicable: monthly, seasonal, annual

Geographic limitation: valid for all Europe

Formula: ∑Tmax≥32°C - on the interval June-August

Reference: Sandu I., Mateescu Elena, Vatamanu V. V, *Schimbari climatice in Romania si efectele asupra agriculturii*, Editura Sitech, Craiova, 2010

39.

ID: D32

Name: Temperature sums above 32°C (duration)

Description: number of days whith TX≥32°C

Importance of the index: Important application in agriculture, water, human health

Time scale applicable: monthly, seasonal, annual

Geographic limitation: valid for all Europe

Formula: number of days whith TX≥32°C

Reference: Klein Tank AMG, Zwiers FW, Zhang X. 2009. Guidelines on analysis of extremes in a changing climate in support of informed decisions for adaptation, climate data and monitoring WCDMP-No 72, WMO-TD No 1500, p 5.



ID: STN15

Name: Sums of minimum air temperatures ≤-15°C recorded in December-February interval Description: the amount of minimum air temperatures below -15°C Importance of the index: Important application in agriculture, energy, human health, tourism Time scale applicable: annual Geographic limitation: valid for all Europe Formula: ∑Tmin≤-15°C recorded in December-February interval Reference: Sandu I., Mateescu Elena, Vatamanu V. V, Schimbari climatice in Romania si efectele asupra agriculturii, Editura Sitech, Craiova, 2010

### 41.

ID: STN10

Name: Sums of minimum air temperatures ≤-10°C recorded in December-February interval Description: Sums of TN ≤-10°C recorded in December-February interval Importance of the index: Important application in agriculture, energy, human health, tourism Time scale applicable: annual Geographic limitation: valid for all Europe Formula: sum TN ≤-10°C recorded in December-February interval Reference: Sandu I., Mateescu Elena, Vatamanu V. V, Schimbari climatice in Romania si efectele asupra agriculturii, Editura Sitech, Craiova, 2010

### 42.

ID: PTG Name: Spring index Description: Sums of positive average temperatures calculated for the 1st of February to the 10th April interval Importance of the index: Important application in agriculture Time scale applicable: annual Geographic limitation: valid for all Europe Formula: ∑Tmed≥0°C calculated from the 1 <sup>st</sup> of February to the 10<sup>th</sup> of April Reference: Sandu I., Mateescu Elena, Vatamanu V. V, *Schimbari climatice in Romania si efectele asupra agriculturii*, Editura Sitech, Craiova, 2010

### **Precipitation based indices**

43.
ID: TP
Name: Total precipitation
Description: Total amounts of precipitation
Importance of the index: Important application in agriculture and water
Time scale applicable: monthly, seasonal, annual
Geographic limitation: valid for all Europe
Formula: Total amounts of precipitation



Reference: Klein Tank AMG, Zwiers FW, Zhang X. 2009. Guidelines on analysis of extremes in a changing climate in support of informed decisions for adaptation, climate data and monitoring WCDMP-No 72, WMO-TD No 1500, p 5.

44.
ID: XP
Name: Maximun precipitation
Description: The highest amount of precipitation
Importance of the index: Important application in agriculture and water
Time scale applicable: monthly, seasonal, annual
Geographic limitation: valid for all Europe
Formula: The highest amount of precipitation
Reference: Klein Tank AMG, Zwiers FW, Zhang X. 2009. Guidelines on analysis of extremes in a changing
climate in support of informed decisions for adaptation, climate data and monitoring WCDMP-No 72,
WMO-TD No 1500, p 5.

45.

ID: R10mm
Name: R10mm
Description: Annual count of days when daily precipitation amount ≥ 10mm
Importance of the index: Important application in agriculture and water
Time scale applicable: monthly, seasonal, annual
Geographic limitation: valid for all Europe
Formula: No. days ≥ 10mm
Reference: Klein Tank AMG, Zwiers FW, Zhang X. 2009. Guidelines on analysis of extremes in a changing
climate in support of informed decisions for adaptation, climate data and monitoring WCDMP-No 72,
WMO-TD No 1500, p 5.

46.

ID: R20mm
Name: R20mm
Description: Annual count of days when daily precipitation amount ≥ 20mm
Importance of the index: Important application in agriculture and water
Time scale applicable: monthly, seasonal, annual
Geographic limitation: valid for all Europe
Formula: No. days ≥ 20mm
Reference: Klein Tank AMG, Zwiers FW, Zhang X. 2009. Guidelines on analysis of extremes in a changing
climate in support of informed decisions for adaptation, climate data and monitoring WCDMP-No 72,
WMO-TD No 1500, p 5.



47.
ID: Rx1day
Name: Rx1day
Description: Maximum 1-day precipitation
Importance of the index: Important application in agriculture and water
Time scale applicable: monthly, seasonal, annual
Geographic limitation: valid for all Europe
Formula: Maximum 1-day precipitation
Reference: Klein Tank AMG, Zwiers FW, Zhang X. 2009. Guidelines on analysis of extremes in a changing
climate in support of informed decisions for adaptation, climate data and monitoring WCDMP-No 72,
WMO-TD No 1500, p 5.

48.

ID: Rx5day

Name: Rx5day

Description: Maximum consecutive 5-day precipitation

Importance of the index: Important application in agriculture and water

Time scale applicable: monthly, seasonal, annual

Geographic limitation: valid for all Europe

Formula: Maximum consecutive 5-day precipitation

Reference: Klein Tank AMG, Zwiers FW, Zhang X. 2009. Guidelines on analysis of extremes in a changing climate in support of informed decisions for adaptation, climate data and monitoring WCDMP-No 72, WMO-TD No 1500, p 5.

### 49.

ID: SDII

Name: SDII

Description: Sum of precipitation in wet days (days with >1mm of precipitation), and dividing that by the number of wet days in the period.

Importance of the index: Important application in agriculture and water

Time scale applicable: monthly, seasonal, annual

Geographic limitation: valid for all Europe

Formula: Sum of precipitation in wet days (days with >1mm of precipitation), and dividing that by the number of wet days in the period.

Reference: Michele Brunetti, Maurizio Maugerib, Teresa Nanni, (2001) Changes in total precipitation, rainy days and extreme events in northeastern Italy, International Journal of Climatology

50. ID: DD Name: Dry days Description: Number of days with less than 1 mm/day Importance of the index: Important application in agriculture and water Time scale applicable: monthly, seasonal, annual Geographic limitation: valid for all Europe Formula: No. days < 1 mm/day



Reference: Klein Tank AMG, Zwiers FW, Zhang X. 2009. Guidelines on analysis of extremes in a changing climate in support of informed decisions for adaptation, climate data and monitoring WCDMP-No 72, WMO-TD No 1500, p 5.

51.
ID: EP
Name: Effective precipitation
Description: Precipitation minus evapotranspiration
Importance of the index: Important application in agriculture and water
Time scale applicable: monthly, seasonal, annual
Geographic limitation: valid for all Europe
Formula: P- ETO
Reference: Klein Tank AMG, Zwiers FW, Zhang X. 2009. Guidelines on analysis of extremes in a changing
climate in support of informed decisions for adaptation, climate data and monitoring WCDMP-No 72,
WMO-TD No 1500, p 5.

52.

ID: LDP

Name: Longest dry period

Description: Maximum length of consecutive dry days (RR<1)

Importance of the index: Important application in agriculture and water

Time scale applicable: monthly, seasonal, annual

Geographic limitation: valid for all Europe

Formula: Maximum number of consecutive dry days of a year

Reference: Gregory J. McCabe, David R. Legates, Harry F. Lins, Variability and trends in dry day frequency and dry event length in the southwestern United States, Journal of Geophysical Research, VOL. 115, D07108, doi:10.1029/2009JD012866, 2010

53.

ID: LWP Name: Longest wet period Description: Maximum length of consecutive wet days (RR>=1) Importance of the index: Important application in agriculture and water Time scale applicable: monthly, seasonal, annual Geographic limitation: valid for all Europe Formula: No. days RR>=1 Reference: Klein Tank AMG, Zwiers FW, Zhang X. 2009. Guidelines on analysis of extremes in a changing climate in support of informed decisions for adaptation, climate data and monitoring WCDMP-No 72, WMO-TD No 1500, p 5.



### ID: PVWD

Name: Precipitation fraction due to very wet days Description: Precipitation at days exceeding the 95percentile divided by total precipitation Importance of the index: Important application in agriculture and water Time scale applicable: monthly, seasonal, annual

Geographic limitation: valid for all Europe

Formula: sum P when RR> 95p/ total precipitation

Reference: Klein Tank AMG, Zwiers FW, Zhang X. 2009. Guidelines on analysis of extremes in a changing climate in support of informed decisions for adaptation, climate data and monitoring WCDMP-No 72, WMO-TD No 1500, p 5.

### 55.

ID: PEWD

Name: Precipitation fraction due to extremely wet days

Description: Precipitation at days exceeding the 99percentile divided by total precipitation

Importance of the index: Important application in agriculture and water

Time scale applicable: monthly, seasonal, annual

Geographic limitation: valid for all Europe

Formula: sum P when RR> 99p/ total precipitation

Reference: Klein Tank AMG, Zwiers FW, Zhang X. 2009. Guidelines on analysis of extremes in a changing climate in support of informed decisions for adaptation, climate data and monitoring WCDMP-No 72, WMO-TD No 1500, p 5.

56.

ID: HPD

Name: Heavy precipitation days Description: Number of days with precipitation above 50mm Importance of the index: Important application in agriculture and water Time scale applicable: monthly, seasonal, annual Geographic limitation: valid for all Europe Formula: No. days RR > 50mm Reference: Klein Tank AMG, Zwiers FW, Zhang X. 2009. Guidelines on analysis of extremes in a changing climate in support of informed decisions for adaptation, climate data and monitoring WCDMP-No 72, WMO-TD No 1500, p 5.

57. ID: R95p Name: R95p Description: Days when precipitation > 95p Importance of the index: Important application in agriculture and water Time scale applicable: monthly, seasonal, annual Geographic limitation: valid for all Europe Formula: No. days RR > 95p



Reference: Klein Tank AMG, Zwiers FW, Zhang X. 2009. Guidelines on analysis of extremes in a changing climate in support of informed decisions for adaptation, climate data and monitoring WCDMP-No 72, WMO-TD No 1500, p 5.

58.
ID: PCI
Name: Precipitation Concentration Index
Description:
Importance of the index: Important application in agriculture and water
Time scale applicable: annual
Geographic limitation: valid for all Europe
Formula:

$$PCI = \frac{\sum_{i=1}^{12} P_i^2}{(P_t)^2} \times 100$$

Reference: J. Martin-Vide, "Spatial distribution of a daily precipitation concentration index in peninsular Spain," International Journal of Climatology, vol. 24, no. 8, pp. 959–971, 2004.

### 59.

ID: MFI Name: fModified Fournier Index Description: A precipitation concentration index Importance of the index: Important application in agriculture and water Time scale applicable: annual Geographic limitation: valid for all Europe Formula:

$$MFI = \sum_{i=1}^{12} \frac{p_i^2}{P_t}$$

Reference: Gabriels, D. (2006). Assessing the Modified Fournier Index and the Precipitation Concentration Index for Some European Countries. In Soil Erosion in Europe (eds J. Boardman and J. Poesen). doi:10.1002/0470859202.ch48

60.

ID: GSP

Name: Growing season precipitation

Description: Growing season (April to October) total precipitation

Importance of the index: Important application in agriculture

Time scale applicable: annual

Geographic limitation: valid for all Europe

Formula: Total precipitation from April to October

Reference: Klein Tank AMG, Zwiers FW, Zhang X. 2009. Guidelines on analysis of extremes in a changing climate in support of informed decisions for adaptation, climate data and monitoring WCDMP-No 72, WMO-TD No 1500, p 5.



ID: NGSP Name: Non-growing season precipitation Description: October to April total precipitation, can inform on the resource available for low potential evaporation conditions Importance of the index: Important application in agriculture Time scale applicable: annual Geographic limitation: valid for all Europe Formula: Total precipitation from October to April Reference: Klein Tank AMG, Zwiers FW, Zhang X. 2009. Guidelines on analysis of extremes in a changing climate in support of informed decisions for adaptation, climate data and monitoring WCDMP-No 72, WMO-TD No 1500, p 5.

### 62.

ID: TPWD Name: Total precipitation in wet days Description: Precipitation amount on days with RR  $\geq$  1 mm in a chosen period (e.g. year) Importance of the index: Important application in agriculture, water management and tourism. Time scale applicable: monthly, seasonal, annual Geographic limitation: valid for all Europe Formula: Tj =  $\sum_{i=1}^{I} RRij$ Let  $RR_{ij}$  be the daily precipitation amount on day *i* in period *j*. If *I* represents the number of days in *j*.

Reference: Karl, T.R., N. Nicholls, and A. Ghazi, 1999: CLIVAR/GCOS/WMO workshop on indices and

indicators for climate extremes: Workshop summary. *Climatic Change*, **42**, 3-7.

### 63.

ID: RR1 Name: Wet days  $\geq$  1 mm Description: Total number of wet days  $\geq$  1 mm; standard index computed by ECA&D Importance of the index: Important application in agriculture, water management and tourism. Time scale applicable: monthly, seasonal, annual Geographic limitation: valid for all Europe Formula: RRij  $\geq$  1mm Let RR<sub>ij</sub> be the daily precipitation amount on day *i* of period *j*. Count the number of days. Reference: ECA&D website: https://www.ecad.eu//indicesextremes/indicesdictionary.php



64.
ID: RR3
Name: Wet days ≥ 3 mm
Description: Total number of wet days ≥ 3 mm; standard index computed by ECA&D
Importance of the index: Important application in agriculture, water management and tourism.
Time scale applicable: monthly, seasonal, annual
Geographic limitation: valid for all Europe
Formula: No. days RR≥ 3mm
Reference: ECA&D website: https://www.ecad.eu//indicesextremes/indicesdictionary.php

### **3.3 Bioclimatic indices**

65. ID: BIO10 Name: BIO10 Description: TG of Warmest Quarter Importance of the index: Important application in agriculture Time scale applicable: annual Geographic limitation: valid for all Europe Formula: TG of Warmest Quarter Reference: http://www.worldclim.org/bioclim

66. ID: BIO11 Name: BIO11 Description: TG of Coldest Quarter Importance of the index: Important application in agriculture Time scale applicable: annual Geographic limitation: valid for all Europe Formula: TG of Coldest Quarter Reference: http://www.worldclim.org/bioclim

67. ID: BIO13 Name: BIO13 Description: Precipitation of Wettest Month Importance of the index: Important application in agriculture Time scale applicable: annual Geographic limitation: valid for all Europe Formula: Precipitation of Wettest Month Reference: http://www.worldclim.org/bioclim



68.
ID: BIO14
Name: BIO14
Description: Precipitation of Driest Month
Importance of the index: Important application in agriculture
Time scale applicable: annual
Geographic limitation: valid for all Europe
Formula: Precipitation of Driest Month
Reference: http://www.worldclim.org/bioclim

69.

ID: BIO15 Name: BIO15

Description: This is a measure of the variation in monthly precipitation totals over the course of the year. This index is the ratio of the standard deviation of the monthly total precipitation to the mean monthly total precipitation (also known as the coefficient of variation) and is expressed as a percentage.

Importance of the index: Important application in agriculture

Time scale applicable: annual

Geographic limitation: valid for all Europe

Formula: the coefficient of variation

Reference: http://www.worldclim.org/bioclim

70.

ID: BIO16 Name: BIO16 Description: Precipitation of Wettest Quarter Importance of the index: Important application in agriculture Time scale applicable: annual Geographic limitation: valid for all Europe Formula: Precipitation of Wettest Quarter Reference: http://www.worldclim.org/bioclim

71. ID: BIO17 Name: BIO17 Description: Precipitation of Driest Quarter Importance of the index: Important application in agriculture Time scale applicable: annual Geographic limitation: valid for all Europe Formula: Precipitation of Driest Quarter Reference: http://www.worldclim.org/bioclim



72. ID: BIO18 Name: BIO18 Description: Precipitation of Warmest Quarter Importance of the index: Important application in agriculture Time scale applicable: annual Geographic limitation: valid for all Europe Formula: Precipitation of Warmest Quarter Reference: http://www.worldclim.org/bioclim

73. ID: BIO19 Name: BIO19 Description: Precipitation of Coldest Quarter Importance of the index: Important application in agriculture Time scale applicable: annual Geographic limitation: valid for all Europe Formula: Precipitation of Coldest Quarter Reference: http://www.worldclim.org/bioclim

74.

ID: BIO4 Name: BIO4 Description: Standard deviation \*100 Importance of the index: Important application in agriculture Time scale applicable: annual Geographic limitation: valid for all Europe Formula: Standard deviation \*100 Reference: http://www.worldclim.org/bioclim

75. ID: BIO5 Name: BIO5 Description: TX of Warmest Month Importance of the index: Important application in agriculture Time scale applicable: annual Geographic limitation: valid for all Europe Formula: TX of Warmest Month Reference: http://www.worldclim.org/bioclim

76. ID: BIO6 Name: BIO6 Description: TN of Coldest Month



Importance of the index: Important application in agriculture Time scale applicable: annual Geographic limitation: valid for all Europe Formula: TN of Coldest Month Reference: http://www.worldclim.org/bioclim

77. ID: BIO7 Name: BIO7 Description: TX of Warmest Month minus TN of Coldest Month Importance of the index: Important application in agriculture Time scale applicable: annual Geographic limitation: valid for all Europe Formula: TX of Warmest Month - TN of Coldest Month Reference: http://www.worldclim.org/bioclim

78.
ID: BIO8
Name: BIO8
Description: TG of Wettest Quarter
Importance of the index: Important application in agriculture
Time scale applicable: annual
Geographic limitation: valid for all Europe
Formula: TG of Wettest Quarter
Reference: http://www.worldclim.org/bioclim

79. ID: BIO9 Name: BIO9 Description: TG of Driest Quarter Importance of the index: Important application in agriculture Time scale applicable: annual Geographic limitation: valid for all Europe Formula: TG of Driest Quarter Reference: http://www.worldclim.org/bioclim

80. ID: BIO20 Name: BIO20 Description: Mean radiation (W m-2) following https://www.edenextdata.com/?q=content/climondbioclimatic-variables-2030 Importance of the index: Important application in agriculture Time scale applicable: monthly, seasonal, annual Geographic limitation: valid for all Europe



Formula: Mean radiation (W m-2) Reference: http://www.worldclim.org/bioclim

81.

ID: UTCI

Name: Universal Thermal Climate Index

Description: Considers dry temperature, relative humidity, solar radiation, and wind speed into account and is regarded as the reference environmental temperature causing strain.

Importance of the index: Important application in tourism, energy and health

Time scale applicable: monthly, seasonal, annual

Geographic limitation: valid for all Europe

Formula: UTCI is a complex function of several meteorological parameters (T2m [C],v10m [m/s],RH [%], cloudiness [%], soil temperature[C]) and additional parameters (latitude, Julian day, local solar time); a comprehensive description may be found at https://goo.gl/by4hH9 ; the coefficients of the polynomial approximation are available at http://www.utci.org/utci\_doku.php (UTCI\_a002.f90 file) and more info on the calculation of other parameters (e.g. Tmrt) may be found in the help files of the BioKlima2.6 software (https://www.igipz.pan.pl/Bioklima-zgik.html)

Reference: Bröde P et al. 2012: Deriving the operational procedure for the Universal Thermal Climate Index (UTCI). International journal of biometeorology 56:3, 481-494.

K.Y. Blazejczyk, G. Epstein, G. Jendritzky, H. Staiger, B. Tinz, Int J Biometeorol., 56:3, 515-535, doi: 10.1007/s00484-011-0453-2.

82.

ID: MI

Name: Mould index

Description: Number of days with a relative humidity over 90% in combination with air temperatures above 10°C.

Importance of the index: Important application in tourism, energy and health

Time scale applicable: monthly, seasonal, annual

Geographic limitation: valid for all Europe

Formula: No. days RH> 90% & TG> 10°C.

Reference: http://www.tut.fi/en/research/research-fields/civil-engineering/structural-

engineering/building-physics/finnish-mould-growth-model/index.htm.

83.

ID: HI

Name: Heat Index

Description: Combines air temperature and relative humidity to determine the human-perceived equivalent temperature

Importance of the index: Important application in tourism, energy and health

Time scale applicable: monthly, seasonal, annual

Geographic limitation: valid for all Europe

Formula: HI= -42,379+(2,04901523)\*T)+(10,14333127\*rh)-(0,22475541\*T\*rh)

 $-(6,83783^{*}10^{-3}*T^{2})-(5,481717^{*}10^{-2}*rh^{2})+(1,22874^{*}10^{-3}*T^{2}*rh)+(8,5282^{*}10^{-4}*T^{*}rh^{2})$ 



-(1,99\*10<sup>-6</sup>\*T<sup>2</sup>\*rh<sup>2</sup>). Where T is air temperature in <sup>o</sup>F and rh is relative humidity in %

Reference: http://www.wpc.ncep.noaa.gov/html/heatindex\_equation.shtml

84.

ID: WCI Name: Wind Chill Index: air temperature + wind Description: is the lowering of body temperature due to the passing-flow of lower-temperature air. It combines air temperature and wind speed. Importance of the index: Important application in energy and tourism Time scale applicable: monthly, seasonal, annual Geographic limitation: valid for all Europe Formula: WCI=13,12+0,6215T-11,37v<sup>0,16</sup>+0,3965Tv<sup>0,16</sup>

Where T is air temperature in <sup>Q</sup>C and v is wind speed in Km/h Reference: : Osczevski, Randall; Bluestein, Maurice (2005). "The new wind chill equivalent temperature chart". Bulletin of the American Meteorological Society. 86 (10): 1453–1458

85.

ID: AT

Name: Apparent temperature

Description: AT = Ta + 0.33e - 0.70v - 4.00; Ta = air temperature in °C ; v = wind speed in m/s; e = water vapor pressure in hPa

Importance of the index: Important application in agriculture

Time scale applicable: monthly, seasonal, annual

Geographic limitation: valid for all Europe Formula:

 $e = \frac{\mathrm{RH}}{100} \cdot 6.105 \cdot \exp\left(\frac{17.27 \cdot T_\mathrm{a}}{237.7 + T_\mathrm{a}}\right)$ 

nere:

AT = Ta + 0.33e -0.70v -4.00; Ta = air temperature in °C ; v = wind speed in m/s; e= water vapor pressure in hPa

Reference: Steadman, R.G., 1984: A Universal Scale of Apparent Temperature. J. Climate Appl. Meteor., 23, 1674–1687, https://doi.org/10.1175/1520-0450(1984)023<1674:AUSOAT>2.0.CO;2

### Wind-based indices

86.

ID: GusTX Name: Days wind gusts above 21 m/s Description: number of days with wind gusts above 21 m/s Importance of the index: Important application in energy and agriculture Time scale applicable: monthly, seasonal, annual Geographic limitation: valid for all Europe Formula: No. days with wind gusts > 21 m/s Reference: Azad, Kalam & Alam, Muhammad. (2010). Determination of Wind Gust Factor at Windy areas of Bangladesh. 10.13140/2.1.2090.6884.



### 87. ID: FXx Name: Maximum value of daily maximum wind gust (m/s) Description: Maximum value of daily maximum wind gust (m/s); standard index computed by ECA&D

Importance of the index: Important application in energy, agriculture and tourism Time scale applicable: monthly, seasonal, annual

Geographic limitation: valid for all Europe

Formula: FXxj = max(FXij) Let  $FX_{ij}$  be the daily maximum wind gust for day *i* of period *j*.) Reference: ECA&D website: <u>https://www.ecad.eu//indicesextremes/indicesdictionary.php</u>

88.

ID: FG

Name: FG

Description: Mean of daily mean wind strength (m/s); standard index computed by ECA&D Importance of the index: Important application in energy, agriculture and tourism Time scale applicable: monthly, seasonal, annual

Geographic limitation: valid for all Europe

Formula:  $FGj = \frac{\sum_{i=1}^{I} FGij}{I}$  Let  $FG_{ij}$  be the daily mean wind strength for day *i* of period *j* Reference: <u>https://www.ecad.eu//indicesextremes/indicesdictionary.php</u>

89.

ID: FGcalm Name: Calm days Description: Number of calm days (FG  $\leq 2$  m/s); standard index computed by ECA&D Importance of the index: Important application in energy and tourism Time scale applicable: monthly, seasonal, annual Geographic limitation: valid for all Europe Formula: FGi $j \leq 2 m/s^{-1}$  Let  $FG_{ij}$  be the daily averaged wind strength for day i of period j. Count the number of days with. Reference: ECA&D website: https://www.ecad.eu//indicesextremes/indicesdictionary.php

90.

ID: FG6Bft

Name: FG6Bft

Description: Number of days with daily averaged wind ≥6 Bft (10.8 m/s) (days); standard index computed by ECA&D

Importance of the index: Important application in energy, agriculture and tourism.

Time scale applicable: monthly, seasonal, annual

Geographic limitation: valid for all Europe

Formula: FGi $j \ge 10.8 m/s^{-1}$  Let FG<sub>ij</sub> be the daily averaged wind strength for day *i* of period *j*. Count the number of days with.

Reference: ECA&D website: <u>https://www.ecad.eu//indicesextremes/indicesdictionary.php</u>



### Aridity/continentality indices

91.

ID: Eto

Name: Reference Evapotranspiration

Description: If data available using Fao-56 Penman-Monteith, if not using the Hargreaves & Samani method.

Importance of the index: Important application in agriculture

Time scale applicable: monthly, seasonal, annual

Geographic limitation: valid for all Europe

Formula: Fao-56 Penman-Monteith or the Hargreaves & Samani method.

Reference: Chiew, F.H.S., Kamaladasa, N.N., Malano, H.M., McMahon, T.A., 1995. Penman–Monteith FAO-24 reference crop evapotranspiration and class-A pan data in Australia. Agric. Water Manage. 28, 9–21

92.

ID: UAI Name: fUNEP Aridity Index Description: P/Eto Importance of the index: Important application in agriculture Time scale applicable: monthly, seasonal, annual Geographic limitation: valid for all Europe Formula: P/Eto Reference: Huiping Huang, Yuping Han, Mingming Cao, Jinxi Song, and Heng Xiao, "Spatial-Temporal Variation of Aridity Index of China during 1960–2013," Advances in Meteorology, vol. 2016, Article ID 1536135, 10 pages, 2016. https://doi.org/10.1155/2016/1536135

93.
ID: CMD
Name: Climatic Moisture Deficit
Description: ETo - Effective Precipitation
Importance of the index: Important application in agriculture
Time scale applicable: monthly, seasonal, annual
Geographic limitation: valid for all Europe
Formula: ETo - Effective Precipitation
Reference: Parks, S. A., Parisien, M. , Miller, C. , Holsinger, L. M. and Baggett, L. S. (2018), Fine-scale
spatial climate variation and drought mediate the likelihood of reburning. Ecol Appl, 28: 573-586.
doi:10.1002/eap.1671

94. ID: MAI Name: De Martonne Aridity Index f Description: Annual rainfall/(Annual TG+10) Importance of the index: Important application in agriculture



Time scale applicable: Annual Geographic limitation: valid for all Europe Formula: Annual rainfall/(Annual TG+10) Reference: Baltas E (2007) Spatial distribution of climatic indices in northern Greece. Meteorol Appl 14: 69–78

95. ID: EAI

Name: Emberger Aridity Index Description: (100\*annual rainfall)/(TGhottest month2-TG coldest month2) Importance of the index: Important application in agriculture Time scale applicable: Annual Geographic limitation: valid for all Europe Formula: (100\*annual rainfall)/(TGhottest month2-TG coldest month2) Reference: Wallén, C. (1967). Aridity Definitions and Their Applicability. Geografiska Annaler. Series A, Physical Geography, 49(2/4), 367-384. doi:10.2307/520903

96.

ID: JCI

Name: Johansson Continentality Index

Description: (1.7E/sinf)-20.4 where E (in8C) is the annual range of mean monthly air temperatures and f is the

geographical latitude of the station

Importance of the index: Important application in agriculture

Time scale applicable: Annual

Geographic limitation: valid for all Europe

Formula: (1.7E/sinf)-20.4 where E (in8C) is the annual range of mean monthly air temperatures and f is the

geographical latitude of the station

Reference: Gavilán RG (2005) The use of climatic parameters and indices in vegetation distribution. A case study in the Spanish Sistema Central. Int J Biometeorol 50: 111–120

97. ID: KOI Name: Kerner Oceanity Index Description: (100\*(To-Ta))/E where To and Ta are the October and April mean values of TG respectively and E is the annual range of monthly mean air temperatures, in °C. Importance of the index: Important application in agriculture Time scale applicable: Annual Geographic limitation: valid for all Europe Formula: (100\*(To-Ta))/E where To and Ta are the October and April mean values of TG respectively and E is the annual range of monthly mean air temperatures, in °C. Reference: Andrade, C. and Corte-Real, J. (2017), Assessment of the spatial distribution of continental-

oceanic climate indices in the Iberian Peninsula. Int. J. Climatol., 37: 36-45. doi:10.1002/joc.4685



ID: PiCI

Name: Pinna Combinative index

Description: 1/2((P/(T+10))+(12Pd/(Td+10))) where P and T are the annual mean values of precipitation and air temperature and P'd, T'd are the mean values of precipitation and air temperature of the driest month

Importance of the index: Important application in agriculture

Time scale applicable: Annual

Geographic limitation: valid for all Europe

Formula: 1/2((P/(T+10))+(12Pd/(Td+10))) where P and T are the annual mean values of precipitation and air temperature and P'd, T'd are the mean values of precipitation and air temperature of the driest month Reference: Baltas, E. (2007), Spatial distribution of climatic indices in northern Greece. Met. Apps, 14: 69-78. doi:10.1002/met.7

99.

ID: BI

Name: Budyko Index

Description: (Rn/L\*P)\*100, where Rn is the mean annual net radiation (also known as the net radiation balance), P is the mean annual precipitation, and L is the latent heat of vaporization for water Importance of the index: Important application in agriculture

Time scale applicable: Annual

Geographic limitation: valid for all Europe

Formula: (Rn/L\*P)\*100, where Rn is the mean annual net radiation, P is the mean annual precipitation, and L is the latent heat of vaporization for water

Reference: Creed, I. F., Spargo, A. T., Jones, J. A., Buttle, J. M., Adams, M. B., Beall, F. D., Booth, E. G., Campbell, J. L., Clow, D., Elder, K., Green, M. B., Grimm, N. B., Miniat, C., Ramlal, P., Saha, A., Scheetven, S., Spittlebeuse, D., Sterling, S., Williams, M. W., Winkler, P. and Yao, H. (2014). Changing

Sebestyen, S., Spittlehouse, D., Sterling, S., Williams, M. W., Winkler, R. and Yao, H. (2014), Changing forest water yields in response to climate warming: results from long-term experimental watershed sites across North America. Glob Change Biol, 20: 3191-3208. doi:10.1111/gcb.12615

100.

ID: MOI

Name: Marsz Oceanity Index

Description:  $(0.731\phi+1.767)$ /Tamp where Tamp is the annual range of the monthly mean air temperatures (°C) and  $\phi$  (hereafter, degrees) is the geographical latitude of the grid point

Importance of the index: Important application in agriculture

Time scale applicable: Annual

Geographic limitation: valid for all Europe

Formula: (0.731+1.767)/Tamp where Tamp is the annual range of the monthly mean air temperatures (°C) and (hereafter, degrees) is the geographical latitude of the grid point

Reference: Gavilán RG (2005) The use of climatic parameters and



### **Snow-based indices**

101.
ID: SS
Name: Snowfall sum
Description: Sum of snowfall
Importance of the index: Important application in water and tourism
Time scale applicable: monthly, seasonal, annual
Geographic limitation: valid for all Europe
Formula: Sum of snowfall
Reference: https://www.ecad.eu/download/millennium/millennium.php#snow

102.

ID: SD0\_10 Name: Snow depth n0to10 Description: The number of days with snow depth in the range 1-10 cm Importance of the index: Important application in water and tourism Time scale applicable: monthly, seasonal, annual Geographic limitation: valid for all Europe Formula: No. days snow depth in the range 1-10 cm Reference: https://www.ecad.eu/download/millennium/millennium.php#snow

103.

ID: SD10\_20 Name: Snow depth n10to20 Description: The number of days with snow depth of 10-20 cm Importance of the index: Important application in water and tourism Time scale applicable: monthly, seasonal, annual Geographic limitation: valid for all Europe Formula: No. days snow depth of 10-20 cm Reference: https://www.ecad.eu/download/millennium/millennium.php#snow

104.
ID: SD
Name: snow depth
Description: mean of daily snow depth
Importance of the index: Important application in water and tourism
Time scale applicable: monthly, seasonal, annual
Geographic limitation: valid for all Europe
Formula: mean of daily snow depth
Reference: https://www.ecad.eu/download/millennium/millennium.php#snow



105.
ID: FSD
Name: Freq. of snow days
Description: number of snow days
Importance of the index: Important application in water and tourism
Time scale applicable: monthly, seasonal, annual
Geographic limitation: valid for all Europe
Formula: No. snow days
Reference: https://www.ecad.eu/download/millennium/millennium.php#snow

106.

ID: MSD Name: mild snowy days Description: number of days with snow depth more than 5 cm. Importance of the index: Important application in water and tourism Time scale applicable: monthly, seasonal, annual Geographic limitation: valid for all Europe Formula: No. days snow depth> 5 cm. Reference: https://www.ecad.eu/download/millennium/millennium.php#snow

107.

ID: HSD Name: heavy snowy days Description: number of days with snow depth more than 50 cm. Importance of the index: Important application in water and tourism Time scale applicable: monthly, seasonal, annual Geographic limitation: valid for all Europe Formula: No. days snow depth> 50 cm. Reference: https://www.ecad.eu/download/millennium/millennium.php#snow

108.

ID: FSC Name: The arrival date of first snow cover Description: first day when there is measurable snow cover Importance of the index: Important application in water and tourism Time scale applicable: Annual Geographic limitation: valid for all Europe Formula: first day with measurable snow cover Reference: https://www.ecad.eu/download/millennium/millennium.php#snow

109.ID: FPSCName: The arrival date of first permanent snow coverDescription: First day of the longest period with consecutive snow cover day



Importance of the index: Important application in water and tourism Time scale applicable: Annual Geographic limitation: valid for all Europe Formula: First day of the longest period with consecutive snow cover day Reference: https://www.ecad.eu/download/millennium/millennium.php#snow

110.

ID: LPSC

Name: The departure date of last permanent snow cover Description: Last day of the longest period with consecutive snow cover day Importance of the index: Important application in water and tourism Time scale applicable: Annual Geographic limitation: valid for all Europe

Formula: Last day of the longest period with consecutive snow cover day Reference: https://www.ecad.eu/download/millennium/millennium.php#snow

111.
ID: ASD
Name: Average snow depth
Description: Average snow depth
Importance of the index: Important application in water and tourism
Time scale applicable: monthly, seasonal, annual
Geographic limitation: valid for all Europe
Formula: Average snow depth
Reference: https://www.ecad.eu/download/millennium/millennium.php#snow

112.

ID: SCD

Name: Amount of snow covered days Description: Amount of snow covered days Importance of the index: Important application in water and tourism Time scale applicable: monthly, seasonal, annual Geographic limitation: valid for all Europe Formula: Amount of snow covered days Reference: https://www.ecad.eu/download/millennium/millennium.php#snow

113.
ID: MS
Name: Maximum snow depth
Description: Maximum snow depth
Importance of the index: Important application in water and tourism
Time scale applicable: monthly, seasonal, annual
Geographic limitation: valid for all Europe
Formula: Maximum snow depth



Reference: https://www.ecad.eu/download/millennium/millennium.php#snow

### **Cloud/radiation based indices**

114.
ID: SSD
Name: sum of sunshine duration
Description: Sunshine duration (hours); standard index computed by ECA&D
Importance of the index: Important application in agriculture and tourism
Time scale applicable: monthly, seasonal, annual
Geographic limitation: valid for all Europe
Formula: sum of sunshine duration
Reference: https://www.ecad.eu//indicesextremes/indicesdictionary.php

115.
ID: SND
Name: sunny days
Description: days with mean cloud cover less than 10%.
Importance of the index: Important application in agriculture and tourism
Time scale applicable: monthly, seasonal, annual
Geographic limitation: valid for all Europe
Formula: No. days CC< 10%.</li>
Reference: Rastogi, B., A.P. Williams, D.T. Fischer, S.F. Jacobellis, K. McEachern, L. Carvalho, C. Jones, S.A.
Paguekas, and C.L. Still. 2016: Spatial and Temporal Patterns of Cloud Cover and Eog Journation in Coastal

Reference: Rastogi, B., A.P. Williams, D.I. Fischer, S.F. Iacobellis, K. McEachern, L. Carvalho, C. Jones, S.A. Baguskas, and C.J. Still, 2016: Spatial and Temporal Patterns of Cloud Cover and Fog Inundation in Coastal California: Ecological Implications. Earth Interact., 20, 1–19, https://doi.org/10.1175/EI-D-15-0033.1

116.

ID: CID

Name: cloudy days

Description: Number of days with cloud base below 100 meter.

Importance of the index: Important application in agriculture and tourism

Time scale applicable: monthly, seasonal, annual

Geographic limitation: valid for all Europe

Formula: No. days cloud base <100 m.

Reference: Rastogi, B., A.P. Williams, D.T. Fischer, S.F. Iacobellis, K. McEachern, L. Carvalho, C. Jones, S.A. Baguskas, and C.J. Still, 2016: Spatial and Temporal Patterns of Cloud Cover and Fog Inundation in Coastal California: Ecological Implications. Earth Interact., 20, 1–19, https://doi.org/10.1175/EI-D-15-0033.1

117.
ID: CC
Name: mean cloud cover
Description: Mean daily cloud cover (oktas)
Importance of the index: Important application in agriculture and tourism
Time scale applicable: monthly, seasonal, annual



Geographic limitation: valid for all Europe

Formula:  $CCj = \sum_{i=1}^{I} CCij/I$  Let CCij be the daily cloud cover for day i of period j. Reference: Huschke, Ralph E. (1970) [1959]. "Cloud cover". Glossary of Meteorology (2nd ed.). Boston: American Meteorological Society. Retrieved 2013-08-24.

118.

ID: SSp

Name: Sunshine duration fraction with respect to day length (%)

Description: Sunshine duration fraction with respect to day length (%); standard index computed by ECA&D.

Importance of the index: Important application in agriculture and tourism

Time scale applicable: monthly, seasonal, annual

Geographic limitation: valid for all Europe

Formula:  $SSj = \sum_{i=1}^{I} SSij$  and  $SSj^{max} = \sum_{i=1}^{I} SSij^{max}$ . This index is then given by:

 $SSpj = 100 * \frac{SSj}{SSj^{max}}$ . Let SSij be the daily sunshine duration for day i of period j and  $SSj^{max}$  the

maximum daylight hours for day I of period j.

Reference: <a href="https://www.ecad.eu//indicesextremes/indicesdictionary.php">https://www.ecad.eu//indicesextremes/indicesdictionary.php</a>

### 119.

ID: ACI

Name: Atmospheric Clarity Index

Description: Ratio between solar radiation at surface and solar radiation at TOA (empirically obtained, see https://goo.gl/Wzs1Zk)

Importance of the index: Important application in agriculture and tourism

Time scale applicable: monthly, seasonal, annual

Geographic limitation: valid for all Europe

Formula: Ratio between solar radiation at surface and solar radiation at TOA

Reference: HONTORIA, L.; AGUILERA, J.; ZUFIRIA, P. Generation of hourly irradiation synthetic series using the neural network multilayer perceptron. Solar Energy, v. 72, n. 5, p. 441-446, 2002.

### **Drought indices**

120.
ID: SPI 1
Name: SPI 1
Description: Standardized precipitation index calculated at 1-month time scale
Importance of the index: Important application in agriculture and water
Time scale applicable: monthly
Geographic limitation: valid for all Europe
Formula: Standardized precipitation index calculated at 1-month time scale
Reference: McKee, T. B., Doesken, N. J. and Kleist, J.: The relationship of drought frequency and duration to time scales, Eighth Conf. Appl. Climatol., 179–184, 1993.



121.
ID: SPI 3
Name: SPI 3
Description: Standardized precipitation index calculated at 3-month time scale
Importance of the index: Important application in agriculture and water
Time scale applicable: monthly
Geographic limitation: valid for all Europe
Formula: Standardized precipitation index calculated at 3-month time scale
Reference: McKee, T. B., Doesken, N. J. and Kleist, J.: The relationship of drought frequency and duration to time scales, Eighth Conf. Appl. Climatol., 179–184, 1993.

122.

ID: SPI 6

Name: SPI 6

Description: Standardized precipitation index calculated at 6-month time scale

Importance of the index: Important application in agriculture and water

Time scale applicable: monthly

Geographic limitation: valid for all Europe

Formula: Standardized precipitation index calculated at 6-month time scale

Reference: McKee, T. B., Doesken, N. J. and Kleist, J.: The relationship of drought frequency and duration to time scales, Eighth Conf. Appl. Climatol., 179–184, 1993.

123.

124.

ID: SPI 12 Name: SPI 12 Description: Standardized precipitation index calculated at 12-month time scale Importance of the index: Important application in agriculture and water Time scale applicable: monthly Geographic limitation: valid for all Europe Formula: Standardized precipitation index calculated at 12-month time scale

Reference: McKee, T. B., Doesken, N. J. and Kleist, J.: The relationship of drought frequency and duration to time scales, Eighth Conf. Appl. Climatol., 179–184, 1993.

ID: SPEI 1 Name: SPEI 1 Description: Standardized precipitation-evapotranspiration index calculated at 1-month time scale Importance of the index: Important application in agriculture and water Time scale applicable: monthly Geographic limitation: valid for all Europe Formula: Standardized precipitation-evapotranspiration index calculated at 1-month time scale Reference: Vicente-Serrano, S. M., Beguería, S. and López-Moreno, J. I.: A multiscalar drought index sensitive to global warming: The standardized precipitation evapotranspiration index, J. Clim., 23(7), doi:10.1175/2009JCLI2909.1, 2010.



ID: SPEI 3

Name: SPEI 3

Description: Standardized precipitation-evapotranspiration index calculated at 3-month time scale Importance of the index: Important application in agriculture and water Time scale applicable: monthly

Geographic limitation: valid for all Europe

Formula: Standardized precipitation-evapotranspiration index calculated at 3-month time scale Reference: Vicente-Serrano, S. M., Beguería, S. and López-Moreno, J. I.: A multiscalar drought index sensitive to global warming: The standardized precipitation evapotranspiration index, J. Clim., 23(7), doi:10.1175/2009JCLI2909.1, 2010.

126.

ID: SPEI 6

Name: SPEI 6

Description: Standardized precipitation-evapotranspiration index calculated at 6-month time scale Importance of the index: Important application in agriculture and water

Time scale applicable: monthly

Geographic limitation: valid for all Europe

Formula: Standardized precipitation-evapotranspiration index calculated at 6-month time scale Reference: Vicente-Serrano, S. M., Beguería, S. and López-Moreno, J. I.: A multiscalar drought index sensitive to global warming: The standardized precipitation evapotranspiration index, J. Clim., 23(7), doi:10.1175/2009JCLI2909.1, 2010.

127.

ID: SPEI 12

Name: SPEI 12

Description: Standardized precipitation-evapotranspiration index calculated at 12-month time scale Importance of the index: Important application in agriculture

Time scale applicable: monthly

Geographic limitation: valid for all Europe

Formula: Standardized precipitation-evapotranspiration index calculated at 12-month time scale Reference: Vicente-Serrano, S. M., Beguería, S. and López-Moreno, J. I.: A multiscalar drought index sensitive to global warming: The standardized precipitation evapotranspiration index, J. Clim., 23(7), doi:10.1175/2009JCLI2909.1, 2010.

### **Fire indices**

128.

ID: FWI

Name: Canadian Fire Weather Index (FWI)

Description: The Canadian Forest Fire Weather Index (FWI) is an indicator of fire weather intensity and is used to represent potential fire danger. It is computed from daily values of precipitation, temperature, near-surface wind and relative humidity

Importance of the index: Important application for fire prevention



Time scale applicable: monthly, seasonal and annual Geographic limitation: valid for all Europe Formula: dimensionless, see Van Wagner (1987) for formula. Reference: Van Wagner CE. 1987. Development and structure of the Canadian forest fire weather index system. Technical Report 35, Canadian Forestry Service: Ottawa, Ontario.

129.

ID: KBDI

Name: Keetch-Byram Drought Index

Description: The Keetch-Byram Drought Index (KBDI) is an indicator of drought conditions and is used to predict wildfire severity. It estimates soil water deficit, or the amount of net rainfall (in inches or cm) that is required to reduce the index to zero.

Importance of the index: Important application for fire prevention

Time scale applicable: monthly, seasonal and annual

Geographic limitation: valid for all Europe

Formula: R package fireDanger

Reference: Keetch, J.J. and Byram, G.M. (1968). A drought index for forest fire control. Tech. Rep., USDA Forest Service Research Paper SE-38, North Carolina, USA.

130.

ID: FFDI

Name: McArthur Forest Fire Danger Index (FFDI)

Description: The McArthur Forest Fire Danger Index (FFDI) has been used in Australia for several decades, generally providing a good indication of the difficulty of fire suppression over a wide range of conditions. It estimates the amount of precipitation needed to bring the soil back to saturation and is computed from the Keetch-Byram Drought Index (KBDI) and Drought Factor (DF).

Time scale applicable: monthly, seasonal and annual

Geographic limitation: valid for all Europe

Formula: inches or cm of precipitation Dimensionless, see Keetch and Byram (1968) for formula.

Reference: McArthur, A. G. (1967). Fire behaviour in eucalypt forests. Forestry and Timber Bureau Leaflet 107, 36 pp.

131.

ID: MNI

Name: Modified Nesterov Index (MNI)

Description: The Modified Nesterov Index (MNI) is based on the Nesterov Index (NI), which was developed in former Soviet Union as an empirical function reflecting the relationship between observed weather conditions and fire occurrence.

Importance of the index: Important application in fire prevention

Time scale applicable: monthly, seasonal and annual

Geographic limitation: valid for all Europe

Formula: Dimensionless, it is a cumulative index computed from daily temperature and dewpoint temperature, which is reset when a certain precipitation value is reached. See Groisman, P.Y., et al. (2007) for formula.

Reference: Groisman, P.Y., et al., 2007. Global and Planetary Change 56, 371–386.



## 132. ID: FFFI Name: Finnish Forest Fire Index (FFFI) Description: Combination of air temperature, relative humidity, wind speed, radiation and precipitation Importance of the index: Important application in tourism Time scale applicable: annual Geographic limitation: valid for all Europe Formula: R package fireDanger Reference: Giannakopoulos C, LeSager P, Moriondo M, Bindi M, Karali A, Hatzaki M, and Kostopoulou E. 2012. Comparison of fire danger indices in the Mediterranean for present day conditions. iForest Biogeosciences and Forestry 5(4):197-203.

### **Tourism indices**

133.
ID: HCI:U
Name: HCI:Urban
Description: Holliday Climate Index for Urban destinations (Scott et all, 2016) (TX, wind, cloudiness, RH, precipitation) Scott, D., Rutty, M., Amelung, B. and Tang, M. (2016): An inter-comparison of the Holiday
Climate Index (HCI) and the Tourism Climate Index (TCI), Atmosphere, 7, 80, doi:10.3390/atmos7060080
Importance of the index: Important application in tourism
Time scale applicable: monthly, seasonal, annual
Geographic limitation: valid for all Europe
Formula: HCI: Urban= 4\*TC +2\*A+(3\*precipitation+wind)

where TC=thermal comfort (as a function of Tmax [C] and RH [%]), A (aesthetic facet)=cloudiness (%), precipitation [mm],wind speed (at 10m)[km/h]. HCI scores may be in the range 0 (potentially dangerous for tourists) to 100 (ideal for tourism).

Reference: Scott, D., Rutty, M., Amelung, B. and Tang, M. (2016): An inter-comparison of the Holiday Climate Index (HCI) and the Tourism Climate Index (TCI), Atmosphere, 7, 80, doi:10.3390/atmos7060080

134. ID: TCI

Name: Tourism Climatic Index

Description: Represents a quantitative evaluation of world climate for the purposes of tourism and is a composite measure of the climatic well-being of tourists.

Importance of the index: Important application in tourism

Time scale applicable: monthly, seasonal, annual

Geographic limitation: valid for all Europe

Formula: TCI = 4cid + cia + 2R + 2S + W, where Cld is a daytime comfort index, Cla a daily comfort index, R is cumulated rainfall, S the daily sunshine hours and W wind speed

Reference: Mieczkowski, Z. (1985). The tourism climatic index: a method of evaluating world climates for tourism. The Canadian Geographer/Le Géographe canadien, 29(3), 220-233.



ID: TCI60 Name: Number of days TCI>60 Description: Number of days TCI>60 (see TCI) Importance of the index: Important application in tourism

Time scale applicable: monthly, seasonal, annual

Geographic limitation: valid for all Europe

Formula: TCI =  $8 \cdot \text{Cld} + 2 \cdot \text{Cla} + 4 \cdot \text{R} + 4 \cdot \text{S} + 2 \cdot \text{W}$ . Let TCI ij be the daily value of the Tourism Climatic Index at day i of period j. Then counted is the number of days where: TCI ij  $\geq 60$ . Where C ld is a daytime comfort index, consisting of the mean maximum air temperature Ta, max (°C) and the mean minimum relative humidity RH (%), Cla is the daily comfort index, consisting of the mean air temperature (°C) and the mean relative humidity (%), R is the precipitation (mm), S is the daily sunshine duration (h), and W is the mean wind speed (m/s).

Reference: Mieczkowski, Z. (1985). The tourism climatic index: a method of evaluating world climates for tourism. The Canadian Geographer/Le Géographe canadien, 29(3), 220-233.

136.

ID: TCI80 Name: Excellent tourism days Description: Number of days TCI>80 (see TCI) Importance of the index: Important application in tourism Time scale applicable: monthly, seasonal, annual Geographic limitation: valid for all Europe Formula: TCI = 8·Cld + 2·Cla + 4·R + 4·S + 2·W. Let TCIij be the daily value of the Tourism Climatic Index at

day i of period j. Then counted is the number of days where: TClij≥80. Where C ld is a daytime comfort index, consisting of the mean maximum air temperature Ta, max (°C) and the mean minimum relative humidity RH (%), Cla is the daily comfort index, consisting of the mean air temperature (°C) and the mean relative humidity (%), R is the precipitation (mm), S is the daily sunshine duration (h), and W is the mean wind speed (m/s).

Reference: Mieczkowski, Z. (1985). The tourism climatic index: a method of evaluating world climates for tourism. The Canadian Geographer/Le Géographe canadien, 29(3), 220-233.