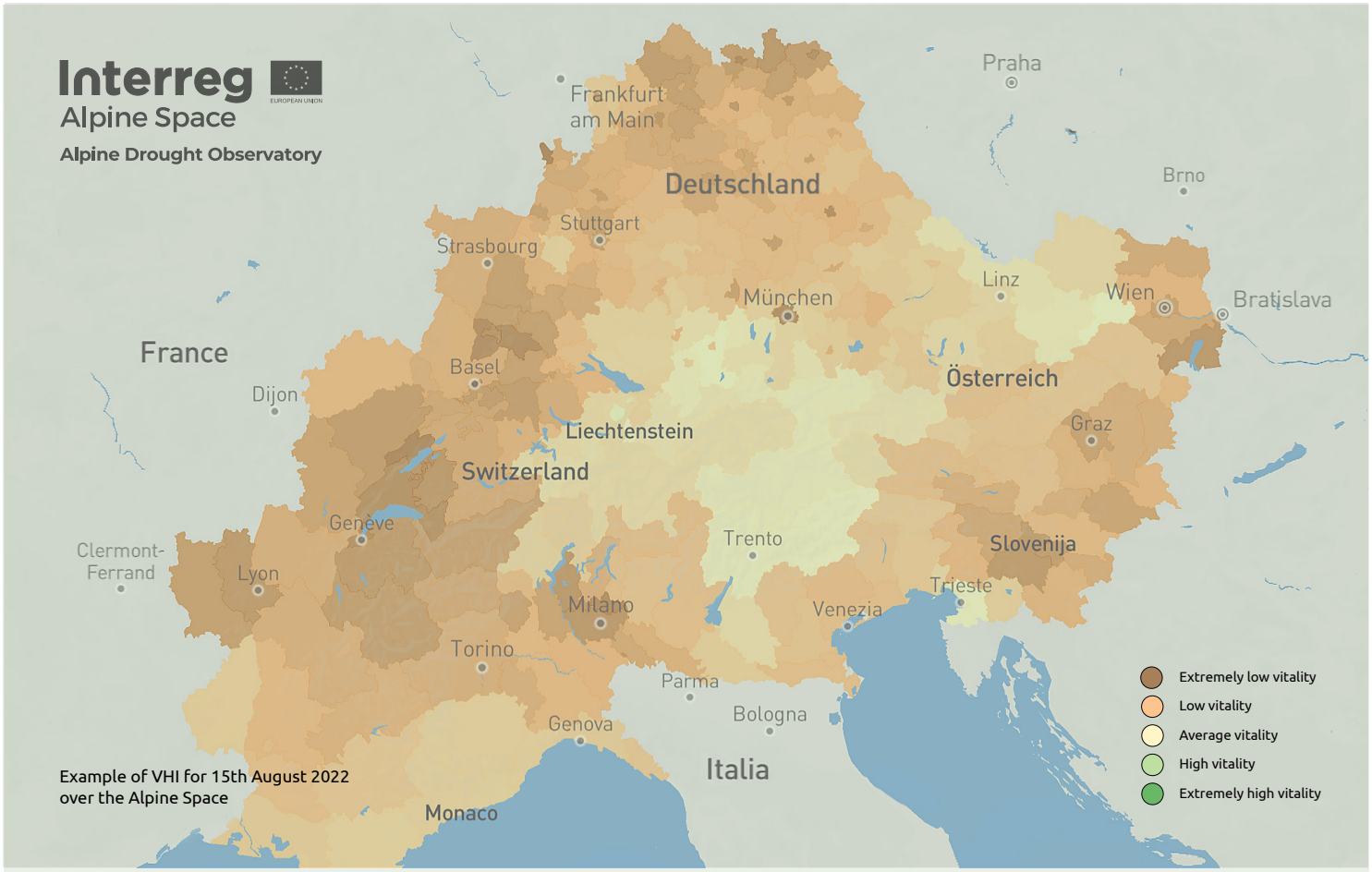

Example of VHI for 15th August 2022 over the Alpine Space

VHI

Vegetation Health Index

This factsheet provides a technical description of the Vegetation Health Index (VHI, Kogan, 1995), which is implemented in the Alpine Drought Observatory (ADO). VHI can be used for detecting agricultural drought and assessing its severity.

Input variable	Type of drought	Temporal resolution	Spatial resolution	Temporal coverage	Time scale (aggregation period)	Unit
NDVI, LST	Agricultural	8 days	231 m	2001–present	8 days	Unitless

Definition

The Vegetation Health Index that is implemented in ADO is used for detecting vegetation stress conditions, which arise when there is limited availability of soil moisture to plants. The VHI allows to identify drought impacts on vegetation which correspond to a combination of thermal stress, which is detected as an increase in Land Surface Temperature (LST), and a decrease in vegetation greenness, which is identified by lower-than-average values of the Normalized Difference Vegetation Index (NDVI). In the ADO project, VHI is computed on an 8-day basis and considers the reference period 2000–2020 for calculating extreme values of NDVI and LST.

Methodology

Data source	Data provider	Index provider	Metadata
MODIS products: MOD09Q1 (surface spectral reflectances, 250 m, 8-day composite) MOD11A2 (LST, 1 km, 8-day average) **Copernicus products:** Corine Land Cover (versions 2000 to 2018)	Eurac	Eurac	Vegetation Health Index Vegetation Condition Index

CALCULATION

For each location (grid-cell), the VHI is calculated as follows:

$$VHI = \alpha\, VCI + (1 - \alpha)\, TCI$$

where VCI is the vegetation condition index, TCI is the thermal condition index, and α determines the share of VCI and TCI in the VHI. Since this share depends on location and time, and is unknown, the weight of both indices was assumed to be equal (α = 0.5).

VCI and TCI are calculated respectively as:

$$VCI = 100\, \frac{NDVI - NDVI_{min}}{NDVI_{max} - NDVI_{min}}$$

$$TCI = 100\, \frac{LST_{max} - LST}{LST_{max} - LST_{min}}$$

where $NDVI$ and LST are the smoothed 8 days $NDVI$ and LST, $NDVI_{min}$ and $NDVI_{max}$, and LST_{min} and LST_{max} are the minimum and maximum NDVI and LST values over the reference multiyear period, for the corresponding compositing period. LST is resampled to the spatial resolution of MODIS reflectances by the nearest neighbor approach, so that original values are preserved.

Both input products, NDVI and LST, are masked to the highest quality standards using the provided MODIS quality layers. Missing pixel values in the NDVI and LST time series are linearly interpolated up to 2021. Non-vegetated areas are masked using the most recent Corine Land Cover product version for the according year. The final product is regridded to the LAEA Projection (EPSG:3035).

INPUT DATA

Input data for the calculation of VHI are MODIS spectral reflectances (MOD09Q1) which are used to calculate NDVI, and LST (MOD11A2). For masking the non-vegetated areas, the Copernicus Corine Land Cover is used.

REFERENCE PERIOD

It is important to define a reference period long enough to realistically capture climate variability in considered regions. ADO project consortium has recommended to use period 1981-2020 as reference where possible (depends on data availability). The reference period for calculating extreme values of LST and NDVI is 2000–2020, corresponding to the length of the MODIS timeseries.

Index values and thresholds

VHI [%]	Drought intensity
< 25	Extreme
25 – 35	Severe
35 – 42	Mild
> 42	None

The value range of the VHI is from 0 (severe vegetation stress) to 100 (very favorable conditions). FAO adopts the threshold values for identifying drought severity classes according to VHI values as shown in the table.

The VHI is based on the assumption that there is a negative correlation between NDVI and LST: during a drought period, NDVI tends to be low, while LST tends to be high (Kloos et al., 2021). This hypothesis should be verified before using the index over a specific region.

Key strengths and weaknesses

VHI

+ The index is simple to calculate.
+ The index identifies both thermal stress and greenness reduction.

– The original resolution of LST is lower than the one of surface reflectance. Thus, there could be inaccuracies over heterogeneous areas.
– The presence of a negative correlation between LST and NDVI should be verified by the user before applying the index.

Findings from the ADO project

1. EVALUATION OF VHI IN ADIGE CATCHMENT AND PODRAVSKA REGION

In the Master's thesis of Kloos (2020) the VHI was applied and evaluated in two Alpine areas, i.e., the Adige catchment and the Slovenian region Podravska. It was found that the vegetation growth within the vegetation period from March to October, especially at high altitudes (> 1500 m) and at the beginning (March and April) and end (September and October) of the vegetation period, is energy limited. However, especially at low altitudes (< 1000 m) and in the middle of the growing season (May to August), vegetation growth is water-limited, which means that VHI can only be applied during these periods and areas. Forest areas generally do not show negative correlations between NDVI and LST. In the region of interest, VHI is positively correlated with precipitation, although this correlation must be differentiated regionally. In addition, the correlation between VHI and measured agricultural yields is strongly positive: VHI can thus record the health status of vegetation and at the same time has the potential to be an indicator of agricultural drought and yield losses.

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