

# Co-developing seamless climate information for the wine sector



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The wine industry is among the agri-food sectors most strongly influenced by climate variability and climate change across multiple time scales. In particular, the integration of reliable and timely climate information into decision-making processes can support the wine sector in better managing climate-related risks, such as spring frost events or water-use restrictions. This has led to growing interest in climate information at these different temporal scales. In the framework of the ASPECT project we apply a user-centred approach, co-developing a case study with a winery in Spain (Codorníu). This case study is being used as the basis of usability and socio-economic assessment of seamless climate information in terms of benefits and added value.

## Wine sector user needs

### Spring frost protection

(March-April)



Just one night of frost (i.e., temperature  $<0^{\circ}\text{C}$ ) in spring can damage the whole production for that year. This might lead to the death of the shoots and new shoots will appear with less fruit than the original ones. Climate information can help at different timescales:



**Short-medium range to decide** if they need to apply management actions to delay bud-break and avoid major damages (e.g. pruning).



**Long term to decide if** they need insurance or to invest in frost prevention systems.



### Water management

(April to September)

Codorníu counts with an irrigation system in the vineyards. In case of droughts, they will need to irrigate with the available water in the reservoirs.



**In the short-medium range**, if there are water restrictions, they might assume a lower production and decide to buy grapes to other producers. This will depend on the length of the drought.



**In the long term**, drought conditions may also impact the choice of other crops to be planted in February in the following years, selecting those with lower water demand.

## Co-developing climate services

### Climate variables and indicators

- **Frost days:** number of days with minimum temperature below  $0^{\circ}\text{C}$ .
- **Growing degree days:** Accumulated sum of daily differences between daily mean temperature and  $10^{\circ}\text{C}$ .

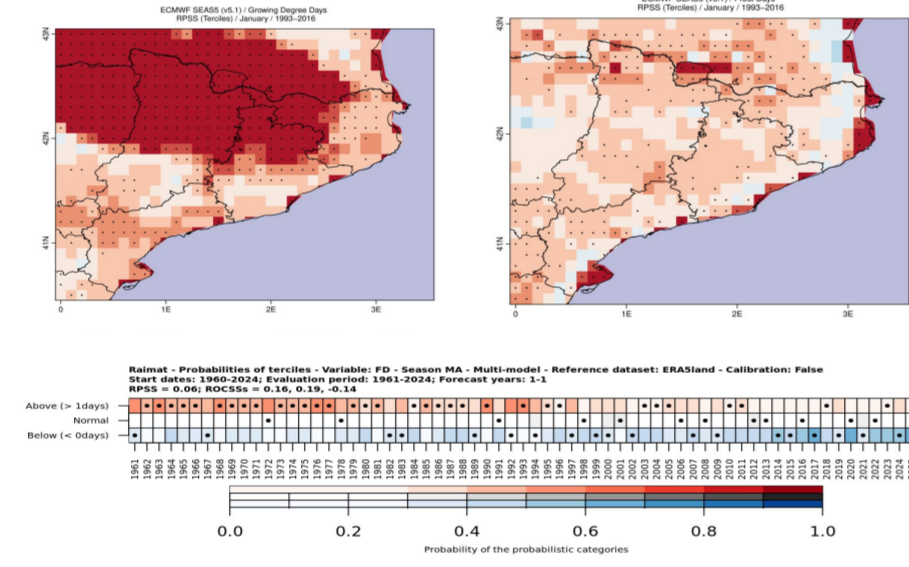
### Climate variables and indicators

- Total **precipitation** and near-surface **temperature**.
- Standardised precipitation and evapotranspiration index (**SPEI**): compares the balance between precipitation and potential evapotranspiration.
- **Growing degree days:** Accumulated sum of daily differences between daily mean temperature and  $10^{\circ}\text{C}$ .
- **Heatwave index:** Times with at least three consecutive days when the daily maximum temperature exceeds  $36^{\circ}\text{C}$ .

## Methodological framework

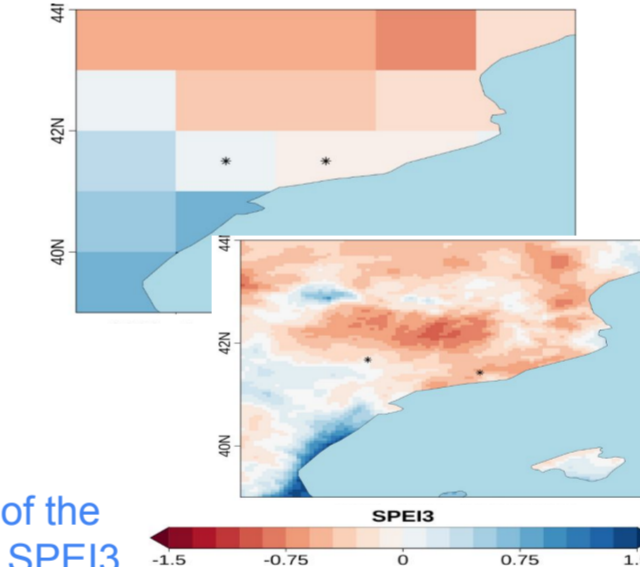
### FORECAST QUALITY ASSESSMENT

A systematic evaluation of the climate predictions of specific climate variables and indicators at different time horizons has been performed. It is available in a Shiny app ([https://earth.bsc.es/shiny/cdelgado\\_ASPECT-wine-casestudy/](https://earth.bsc.es/shiny/cdelgado_ASPECT-wine-casestudy/))



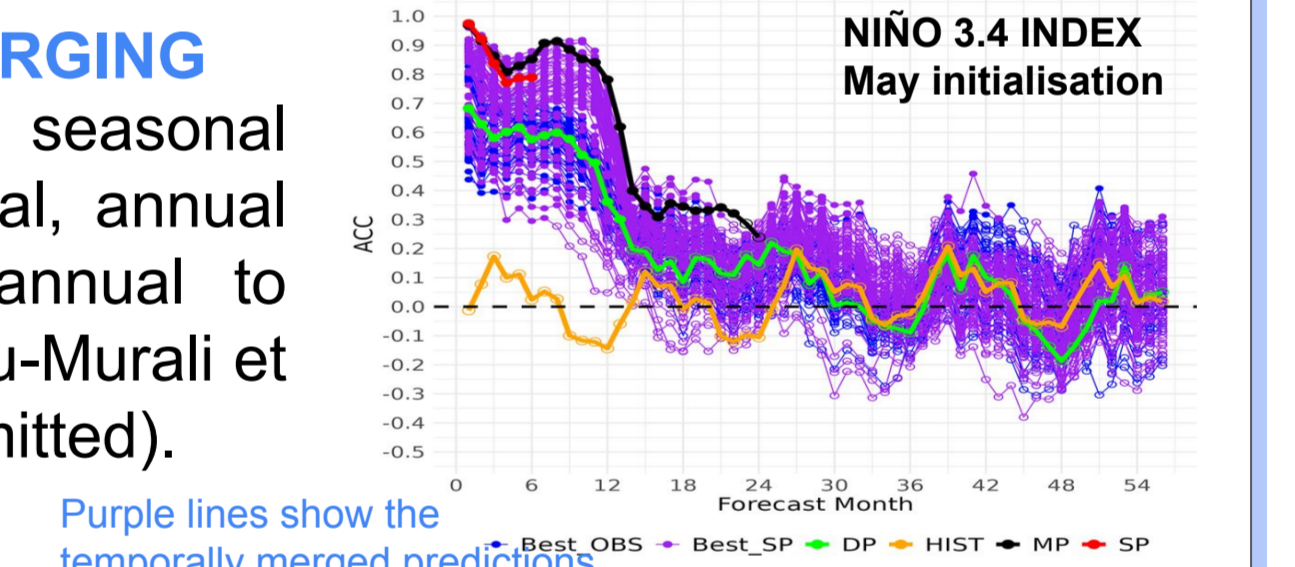
### STATISTICAL DOWNSCALING

Adaptation of the coarse climate model outputs to provide high-resolution and/or local information. Interpolation methods have been combined with bias adjustment, regression techniques and analogue-based methods focusing on large-scale atmospheric circulation (Duzenli et al., 2026; Moreno-Montes et al., 2026; Roncoroni and Athanasiadis, 2026)



### TEMPORAL MERGING

Decadal predictions are constrained by using seasonal predictions and/or observations. Combining seasonal, annual and multi-annual predictions, more skillful multi-annual to decadal climate predictions can be obtained (Solaraju-Murali et al. 2025, Delgado-Torres et al. 2026, Abid et al. submitted).



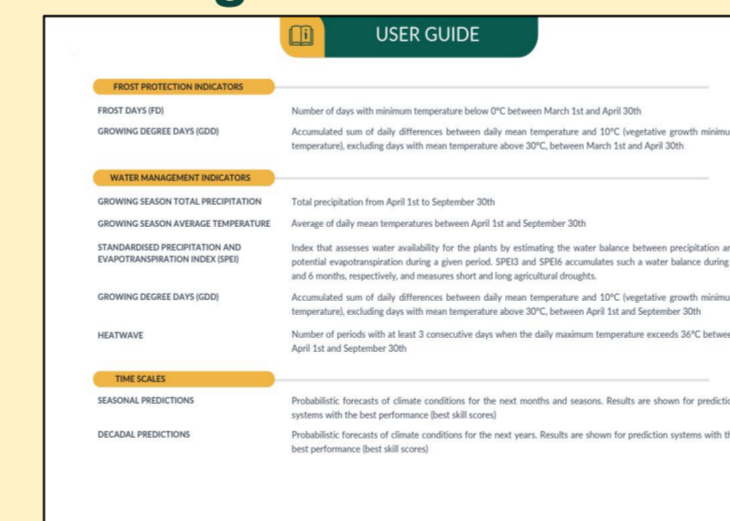
## Delivery format

BSC and Codorníu have co-developed a **bulletin**: it combines maps of seasonal and decadal forecasts for the coming months and years with user-tailored indicators, interpretive analysis, and practical guidance. It is designed to provide a concise summary of the most relevant information to support key vineyard management decisions for the company.

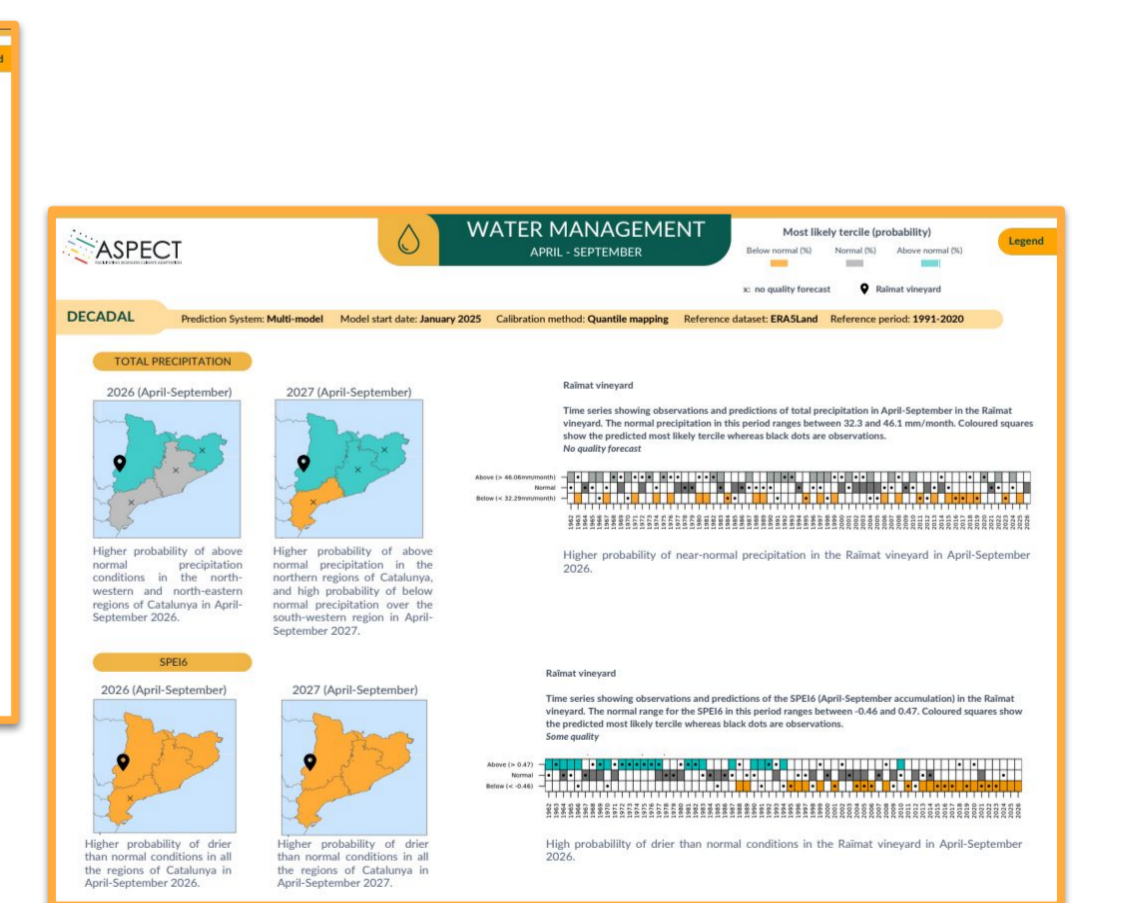
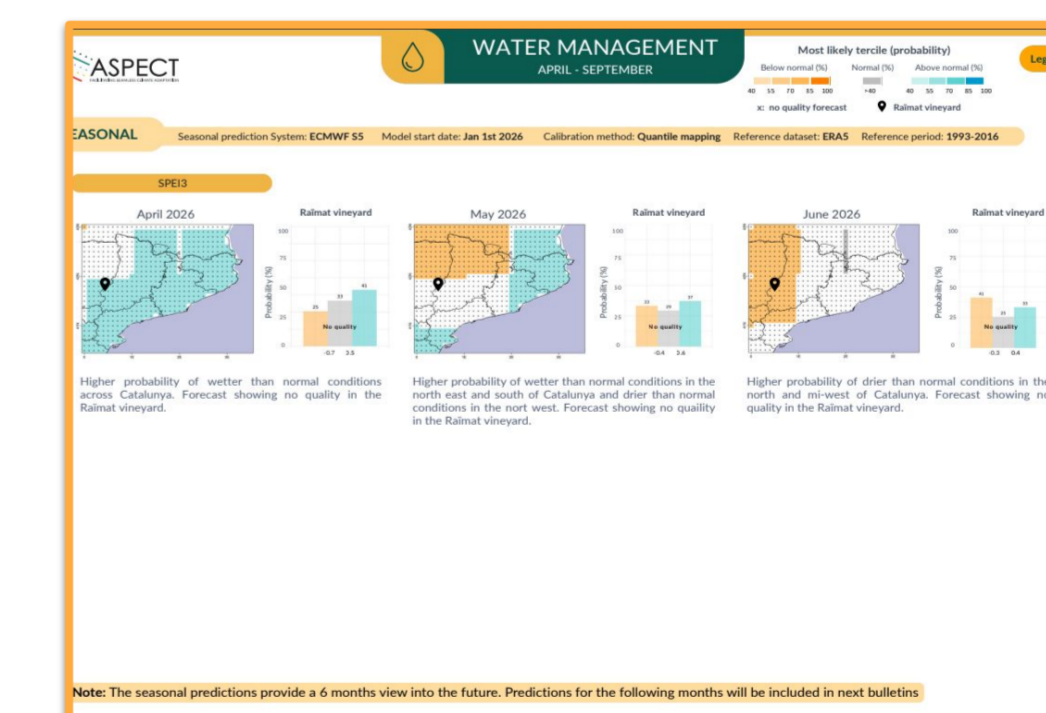
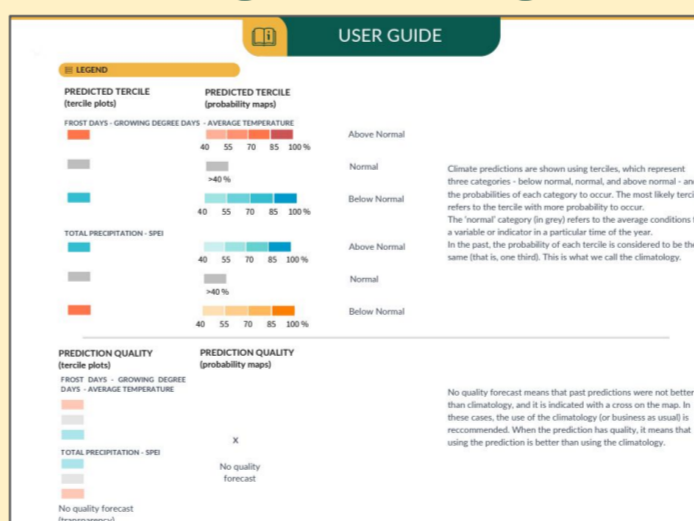
### Bulletin overview



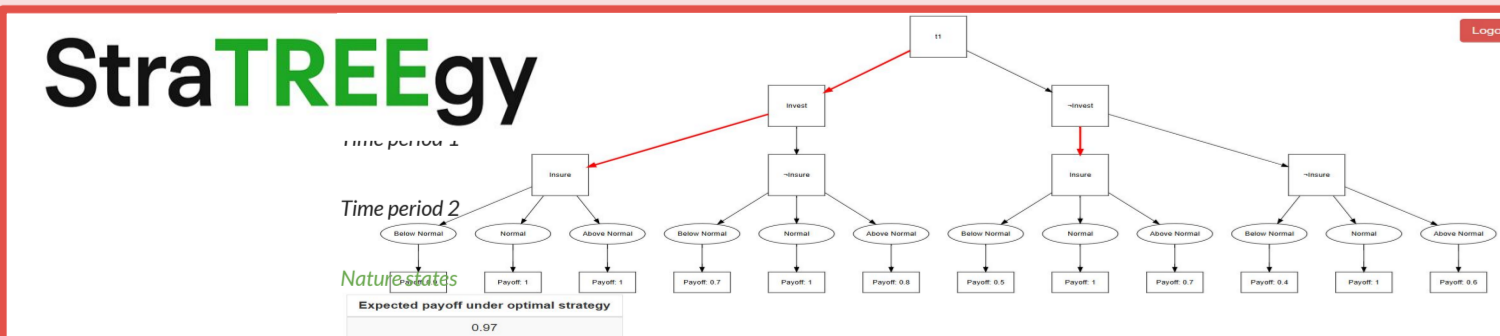
### User guide - indicators



### User guide - legends



## Value assessment



BSC and Codorníu have co-developed **StratREEgy**, a dynamic economic decision-support tool that visualises decision trees and helps guide decisions under uncertainty using probabilistic information. Alternative strategies are assessed through cost minimisation or profit maximisation using both baseline climate information (climatology) and enhanced climate services. Decisions are optimised through backward induction, where later-stage decisions are solved first and used to inform earlier choices, enabling assessment of the added value of improved climate information.

StratREEgy has been used to optimise spring frost risk management for Codorníu. Each year, the company decides whether to **install frost protection systems and renew insurance**.

StratREEgy can be also used for the water management. The same frost protection systems can be used to irrigate the plants and **mitigate the impacts of heatwaves** in the vineyards. In addition, climate information regarding water availability can be also used to decide on the **insurance**.