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MED-GOLD

Turning climate-related information into added value for traditional **MED**iterranean **G**rape, **OL**ive and **D**urum wheat food systems

Deliverable 6.19

Compilation of Publications Abstracts n.2

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All partners involved in the production/implementation of the deliverable should comment and report (if needed) in the above table. The above table should support the decisions made for the specific deliverable in order to include the agreement of all involved parties for the final version of the document.

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Disclaimer

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EXECUTIVE SUMMARY

This compilation of publications abstracts provides an overview of the efforts done within the MED-GOLD consortium to inform and connect end-user communities for the global olive oil, wine, and pasta food systems, and their related policy-making. Med-Gold publication abstracts are being collected in three separate deliverables. Twenty-six abstracts were compiled in the first deliverable [RD.1]. This second deliverable presents abstracts submitted by Med-Gold partners between September 2019 and September 2020. Fourteen additional abstracts have been collected in the second deliverable, and these are summarised in Table 6-1. The next step will be the compilation of abstracts no. 3, in month 42 of the project.

1. OBJECTIVES

This deliverable compiles abstracts submitted by Med-Gold partners between September 2019 and September 2020. The abstracts covered topics of interest for the targeted sectors of climate, grapes/wine, olives/olive oil, and agriculture in general. The aim is to build better informed and connected end-user communities for the global olive oil, wine, and pasta food systems, and related policy making (GA, Part B Table 1-1).

Table 1-1 project objectives

No.	Objective	Yes
1	To co-design, co-develop, test, and assess the added value of proof-of-concept climate services for olive, grape, and durum wheat	
2	To refine, validate, and upscale the three pilot services with the wider European and global user communities for olive, grape, and durum wheat	
3	To ensure replicability of MED-GOLD climate services in other crops/climates (e.g., coffee) and to establish links to policy making globally	
4	To implement a comprehensive communication and commercialization plan for MED-GOLD climate services to enhance market uptake	
5	To build better informed and connected end-user communities for the global olive oil, wine, and pasta food systems and related policy making	x

2. IMPACT

This deliverable supports Task 6.3 which focuses on the dissemination and capacity building towards policy-makers and general public whose aim is to support the implementation of the EU mitigation and adaptation policies to climate change through better-informed decisions particularly in key vulnerable sectors. This compilation of publication abstracts is intended to raise awareness amongst global end users of olive oil, wine and pasta food systems about Med-Gold work and services. Table 2-1 shows the expected impact of this deliverable contribution.

Table 2-1

No.	Expected impact	Yes
1	Providing added-value for the decision-making process addressed by the project, in terms of effectiveness, value creation, optimised opportunities and minimised risk	
2	Enhancing the potential for market uptake of climate services demonstrated by addressing the added value	
3	Ensuring the replicability of the methodological frameworks for value added climate services in potential end-user markets	
4	To implement a comprehensive communication and commercialization plan for MED-GOLD climate services to enhance market uptake	

5	To build better informed and connected end-user communities for the global olive oil, wine, and pasta food systems and related policy making	X

3. DEFINITIONS

Concepts and terms used in this document that require a definition are tabled below:

Table 3-1 Definitions

Concept / Term	Definition
Climate service	Timely production and delivery (translation and transfer) in customized products (projections, forecasts, information, trends, economic analysis, assessments, etc.) of useful climate-related data, information and knowledge that support adaptation, mitigation and disaster risk management to decision makers.
Value	The word 'value' has been defined as the range of benefits (economic and/or non-economic) that can be gained from using climate information in decision-making.
End-user	Organization or person who ultimately uses or is intended to use a product or service.
Communication	Taking strategic and targeted measures for promoting the action itself and its results to a multitude of audiences, including the media and the public, and possibly engaging in a two-way exchange.
Dissemination	Public disclosure of the results by an appropriate communication channel (not only by scientific publications in any medium).
DELPHI	A crop model developed and maintained by the JRC, providing durum wheat yield forecasts and scenarios to BARILLA
Decadal predictions	Predictions for the next 10 years, from which climate information on the next 2-10 years can be extracted. These predictions are affected both by the initial state of the climate system (present-day) and by the near-term projected increase in the concentration of greenhouse gases.

4. ACRONYMS

Acronyms used in this document and needing a definition are included in the following table:

Table 4-1 Acronyms

Acronym	Definition
PBDM	Physiologically based demographic modelling
SATP	South American tomato pinworm
CBB	Coffee berry borer
RUE	Radiation use efficiency
SISC	Italian Society for Climate Sciences

WMO	World Meteorological Organization
CDS	Climate Data Store
HD	High density
SHD	Super high density
PAR	Photosynthetically active radiation
ICCS6	6th International Conference on Climate Services
EMS	European Meteorological Society
GA	Grant Agreement
EGU	European Geosciences Union
GFCS	Global Framework for Climate Services

5. REFERENCES

The following documents, although not part of this document, amplify or clarify its contents. Reference documents are those not applicable and referenced within this document. They are referenced in this document in the form [RD.x]:

Table 5-1 Reference Documents

Ref.	Title	Code	Version	Date
[RD.1]	Compilation of Publications Abstracts no. 1	-	-	2019
[RD.2]	Campos M.R., Béarez P., Amiens-Desneux E., Ponti L., Gutierrez A.P., Biondi A., Adiga A., Desneux N. 2020. Thermal biology of Tuta absoluta: demographic parameters and facultative diapause. Journal of Pest Science. DOI:10.1007/s10340-020-01286-8.	-	-	2020
[RD.3]	Cure J.R., Rodríguez D., Gutierrez A.P., Ponti L. The coffee agroecosystem: bio-economic analysis of coffee berry borer control (Hypothenemus hampei). Scientific Reports, https://doi.org/10.1038/s41598-020-68989-x.	-	-	2020
[RD.4]	Calmanti S., Dell'Aquila A., Ponti L., Monotti C., Bruno Soares M., De Felice M., Graça A., Fontes N., Teixeira M., López-Nevado J., Marcos-Matamoro R., Terrado M., Soret A., Pasqui M., Sanderson M., MED-GOLD Team. Development of climate services from the user	-	-	2019

	perspective: the MED-GOLD experience. European Meteorological Society (EMS) Annual Meeting, Copenhagen, Denmark, 9-13 September 2019. EMS Annual Meeting Abstracts, Vol. 16: Abstract EMS2019-526.			
[RD.5]	Rosati A., Wolz K.J., Murphy L., Ponti L., Jose S., 2020. Modelling light below tree canopies overestimates net photosynthesis and radiation use efficiency in understory crops by averaging light in space and time. Agricultural and Forest Meteorology, https://doi.org/10.1016/j.agrformet.2019.107892.	-	-	2020
[RD.6]	ihailescu E., and Bruno Soares M. 2020. The Influence of Climate on Agricultural Decisions for Three European Crops: A Systematic Review. Front. Sustain. Food Syst. 4:64. doi: 10.3389/fsufs.2020.00064		-	2020
[RD.7]	Perrels A., 2020. Quantifying the uptake of climate services at micro and macro level. Climate Services.17: 100152	-	-	2020

6. DETAILED REPORT

6.1. STATE OF THE ART

Dissemination and communication of results is mandatory in European research and innovation projects, especially Horizon 2020. Good dissemination can increase the impact of research. Compiling abstracts can publicise and help circulate Med-Gold's results to those who can best make use of them (beyond Med-Gold), as well as helping the end-users to connect.

6.2 METHODS

Compiling the abstracts submitted by Med-Gold partners began with an email sent to all Work Packages' mailing lists to request submission abstracts in the targeted sectors of climate, grapes/wine, olives/olive oil and agriculture in general.

6.3 MAIN RESULTS

Fourteen submitted abstracts have been collected by this deliverable and categorised into the five sectors of agriculture, climate, wine, grape and wheat. These are summarised in Table 6-1.

Table 6-1 Abstracts collected by this deliverable

No	Title	Type of publication/event	Year /Location	Sector
1	Thermal biology of Tuta absoluta: demographic parameters and facultative diapause.	Journal article	2020	Agriculture
2	Global pest invasions: why correlative risk assessment may be wrong	Journal article	2020	Agriculture
3	The coffee agroecosystem: bio-economic analysis of coffee berry borer control.	Scientific Reports	2020	Agriculture
4	MED-GOLD Living Lab 2020: the story of an online training event.	Conference	2020,on line	Climate
5	Development of climate services from the user perspective: the MED-GOLD experience.	EMS Annual Meeting,	2019 Copenhagen, Denmark,	Climate
6	Modelling light below tree canopies overestimates net photosynthesis and radiation use efficiency in understory crops by averaging light in space and time	Journal article	2020	Climate
7	Turning climate data into value for productive activities in the user's perspective. Seventh Annual Conference of the Italian Society for Climate Sciences (SISC),	Conference	2019 Trento, Italy	Climate
8	Exploring the added-value of MED-GOLD climate services across crops and agricultural regions.	Conference	2020 Pune, India	Climate
9	The Influence of Climate on Agricultural Decisions for Three European Crops: A Systematic Review.	Journal article	2020	Climate
10	Yield prediction of durum wheat: the added value of MED-GOLD climate services products.	22nd EGU General Assembly	2020	Durum wheat
11	Intercepted PAR and spatial and temporal distribution of transmitted PAR under high density and super high-density olive (Olea europaea L.) orchards. Trees.	Journal article		Olive
12	What light is available for understory crops under high-density and super-high-density olive orchards? Spatial and temporal patterns of transmitted PAR	5th European Agroforestry Conference	May 2020 Sardinia	Olive
13	The Risk of Unprecedented Rainfall in Wine Regions of Northern Portugal	Journal article	2020	Wine

14	Turn climate information into value for the Mediterranean wine sector: the MED-GOLD potential.	22nd EGU General Assembly	May 2020 Online	Wine

6.3.1. Abstracts submitted for Agriculture

1. **Campos M.R., Béarez P., Amiens-Desneux E., Ponti L., Gutierrez A.P., Biondi A., Adiga A., Desneux N. 2020. Thermal biology of Tuta absoluta: demographic parameters and facultative diapause. Journal of Pest Science, doi:10.1007/s10340-020-01286-8 [RD.2]**

The South American tomato pinworm (SATP), Tuta absoluta, is now a devastating pest worldwide of crops in the family Solanaceae. Most prior studies of SATP's thermal biology were based on populations from tropical regions, and proved unsuitable for explaining its invasion of large areas of the Palearctic. A more holistic approach to the analysis of its thermal biology is an essential background for developing models to assess its invasive potential. Our studies found that SATP has lower and upper thermal thresholds (theta-L = 5.37 °C and theta-U = 35.69 °C respectively) than South American populations used in prior studies (theta-L = 7.38°C and theta-U = 33.82°C). Age-specific life tables were used to estimate the effects of temperature on its demographic parameters. Diapause in SATP had not been characterized prior to our study. We found facultative diapause in pupae developing from larvae exposed to relatively low temperatures (i.e. 2 and 5 °C) and short-day length for different exposure periods. The strength of diapause was measured as an increase in post-treatment developmental times of pupae (i.e. degree days) that on average were 2.45 - 3fold greater than of pupae reared at favourable temperatures. A lower developmental threshold and a facultative diapause increase the invasive potential of SATP in temperate areas. Knowledge of this thermal biology is essential for predicting the potential geographic spread of this pest and to develop management and control strategies.

2. **Ponti L., Gutierrez AP., Campos MR., Biondi A., Neteler M., Desneux N. 2020. Global pest invasions: why correlative risk assessment may be wrong. Global Change Biology (Submitted).**

Assessment of invasion risk from crop pests before they invade new regions globally is essential but requires the ability to predict their potential geographic range and level of risk in novel areas. This is often unachievable using de facto standard correlative methods as shown for Tuta absoluta, a serious insect pest of tomato native to South America. Its global invasive potential was not identified until after rapid invasion of Europe, followed by Africa and Asia where it became a major food security problem on solanaceous crops. We show that early prospective assessment using physiologically based demographic modelling (PBDM) would have identified knowledge gaps in Tuta absoluta biology at low temperatures, enabling identification of the risk before invasion occurred. These PBDM methods are applicable generally to all

potential invasive species of any taxa. The PBDM approach enables capturing realistic weather-driven biology in a mechanistic way that can be projected with confidence into novel areas and climes, and hence it fills a distinct methodological gap in invasive species assessment and management under climate change that has prevented invasion biology from becoming a more predictive science.

3. **Cure JR., Rodríguez D., Gutierrez AP., Ponti L. The coffee agroecosystem: bio-economic analysis of coffee berry borer control. Scientific Reports. doi.org/10.1038/s41598-020-68989-x. [RD.3]**

Coffee, after petroleum, is the most valuable commodity globally in terms of total value (harvest to coffee cup). Here, our bioeconomic analysis considers the multitude of factors that influence coffee production. The system model used in the analysis incorporates realistic field models based on considerable new field data and models for coffee plant growth and development, the coffee/coffee berry borer (CBB) dynamics in response to coffee berry production and the role of the CBB parasitoids and their interactions in control of CBB. Cultural control of CBB by harvesting, clean-up of abscised fruits, and chemical sprays previously considered are reexamined here to include biopesticides for control of CBB such as entomopathogenic fungi (Beauveria bassiana, Metarhizium anisopliae) and entomopathogenic nematodes (Steinernema sp., Heterorhabditis). The bioeconomic analysis estimates the potential of each control tactic singly and in combination for control of CBB. The analysis explains why frequent intensive harvesting of coffee is by far the most effective and economically viable control practice for reducing CBB infestations in Colombia and Brazil.

6.3.2. Abstract submitted for climate sector

4. **Dell'Aquila A., Calmanti S., Ponti L., Bruno Soares M., Pasqui M., Sanderson M., Caboni F. The story of an online training event, The MED-GOLD Living Lab organization team. CLIMRISK conference, 21-23 October 2020, Online conference.**

The H2020 MED-GOLD Living Lab ‘‘Turning climate information into value for traditional Mediterranean agri-food systems” was implemented as a solution to deal with the coronavirus pandemic and the resulting travel restrictions. Originally planned as a summer school in Cagliari in Italy, this training event was held online over five weeks between May and June 2020. The Living Lab was implemented through weekly sessions of interactive webinars delivered by experts across different disciplines and online working groups with multidisciplinary teams, supported by scientists from the MED-GOLD project acting as mentors. This work describes the main features of the MED-GOLD Living Lab 2020, including the necessary steps and the strategy adopted to turn the originally planned physical summer school into an online event. Taking into account the circumstances of the COVID-19 emergency and based on the feedback by the participants, the Living lab was a successful experiment that could be replicated and further enhanced for the second training event, planned for late spring 2021.

5. **Calmanti S., Dell'Aquila A., Ponti L., Monotti C., Bruno Soares M., De Felice M., Graça A., Fontes N., Teixeira M., López-Nevado J., Marcos-Matamoro R., Terrado M., Soret A., Pasqui M., Sanderson M., MED-GOLD Team. Development of climate services from the user perspective: the MED-GOLD experience. European Meteorological Society (EMS) Annual Meeting, Copenhagen, Denmark, 9-13 September 2019. EMS Annual Meeting Abstracts, Vol. 16: EMS2019-526 [RD.4]**

Transforming climate-related information into added (economic) value requires a suitable language for a precise quantitative definition of technical concepts that are rather vague for non-experts. While the scientific (climate modelling) community has developed a set of formal definitions for concepts such as skill and reliability of climate predictions, those are not always equally understood by the potential end-users in many sectors. The project MED-GOLD is addressing the lack of a common and agreed terminology between users and providers of climate information in the context of the agri-food industry of traditional Mediterranean products, including grapes/wine, olives/olive oil, and durum wheat/pasta, as a fundamental factor to generate trust in climate services among the user community. Rather than sticking to the technical concepts used by scientists, a common terminology is being co-developed between users and scientists to allow a shared understanding of the key concepts relevant to users' decision- making, and thus fostering essential trust in the resulting services.
During a recent participatory workshop, with contributions from climate scientists and experts from the agri-food industry, a set of guidelines has been identified in order to develop quantitative definitions of the value of climate information. This has been done by linking the occurrence of false alarms and hit rates to information associated with specific users' actions. On the basis of these outcomes, the first release of the tools tailored to the agri-food systems of interest for MED- GOLD (grapes/wine, olives/olive oil, and durum wheat/pasta) has been recently done, and the tools are now in the testing phase through close interaction with the users. Here we present the most recent advancements and propose a bottom-up approach to the definition of the reliability of climate information.

6. **Rosati A., Wolz K.J., Murphy L., Ponti L., Jose S., 2020. Modelling light below tree canopies overestimates net photosynthesis and radiation use efficiency in understory crops by averaging light in space and time. Agricultural and Forest Meteorology, https://doi.org/10.1016/j.agrformet.2019.107892 [RD.5]**

By averaging in time and/or space, models predict less variable light patterns under tree canopies than in reality. We measured light every minute in 24 positions in a grid under different chestnut orchards, for several clear and overcast days. We also modelled this light with a purposely created 3D, spatially explicit, ray-tracing light interception model, where canopy porosity was calibrated to match measured daily light. Finally, we used both the measured and modelled light patterns transmitted under the tree canopies to estimate the daily net photosynthesis (An) and radiation use efficiency (RUE) of an understory wheat leaf. As expected, modelled light was more uniform than measured light, even at equal daily light. This resulted

in large overestimation of daily An and RUE of the understory leaf. Averaging light in time increased the overestimations even further. A sensitivity analysis showed that this overestimation remained substantial over the range of realistic values for leaf photosynthetic parameters (i.e. Vc,max, Jmax, Rd) of the understory crop.

7. **Dell'Aquila A., Calmanti S., Catalano F., Cionni I., Petitta M., Ponti L. Turning climate data into value for productive activities in the user's perspective. Seventh Annual Conference of the Italian Society for Climate Sciences (SISC), Trento, Italy, 23-25 October 2019.**

Climate variability and its impacts has recently received an increasing amount of interest within and well beyond the international climate science community, reaching policy makers, local administrations and stakeholders. Increasing the quality, reliability and detail of climate information for societal use has become a major challenge in regions whose economic growth and social development crucially depend on adaptation to climate variability and change. In the last years several initiatives at European (FP7, H2020, JPI, COPERNICUS) and International level (WMO-Global Framework Climate Services GFCS) are supporting the development of climate services, with the ambition of turning the huge amount of climate data actually available into tailored, accessible and usable information to be included in the end-users' decisional process. Climate services must focus on very different productive sectors and on their different requirements, in terms of targeted climate information, forecast time horizon and acceptable level of uncertainty. It is not enough to produce only meteorological information in the services, but it is especially needed to quantify vulnerabilities to climate variability within the sectors and come up with appropriate adaptation solutions. To this regard, climate services do not only create user-relevant climate information, but also stimulate the need to quantify vulnerabilities and come up with appropriate adaptation solutions that can be applied in practice. The terminology adopted is pivotal to the successful co-development of climate services. However, rather than sticking to the technical concepts used by scientists, it is imperative that such terminology is discussed and co-developed between users and scientists to allow a shared understanding of the key concepts relevant to users' decision-making. Here we present recent activities research developed by Climate & Impact Modeling Lab in ENEA in the framework H2020 projects MED-GOLD, S2S4E, SECLI-FIRM devoted to fill this gap in the development of prototype climate services particularly for agriculture and energy sector. ClimRisk19 – Climate Risk: implications for ecosystem services and society, challenges, solutions.

8. **Mihailescu E., and Bruno Soares M. 2020. The Influence of Climate on Agricultural Decisions for Three European Crops: A Systematic Review. Front. Sustain. Food Syst. 4:64. doi: 10.3389/fsufs.2020.00064 [RD.6]**

The severity and uneven distribution of the expected climate change impacts across climate-sensitive agricultural areas, and the cropping systems operated within, call for identification, and effective management of these impacts. The climate services have the potential to help identifying and adequately

addressing the expected changes in climate and their impacts on agricultural production systems. However, the development of effective climate services is conditioned by the need to clearly understand the critical decisions that underpin end-users' activities and how climate information can support those decision-making processes. This paper reviews and identifies the main decisions linked to key climate change impacts on the cropping systems of interest—olive, grape and durum wheat—in order to inform the development of climate services for these crops in the future. Our review results indicate two types of key findings: (i) the most common types of decisions across the three cropping systems address the increase in temperature, variability, and uneven distribution of rainfall, occurrence of extreme events, and increased solar radiation; (ii) the most common decisions are likely to be affected by an increase in temperature above the maximum supported by the three crops, or in combination with other impacting climate changes. These decisions mainly relate to irrigation and other water stress reducing measures (olive, durum wheat), choice of varieties (grape, durum wheat), clones and rootstocks (grape), training system and vine load (olive, grape), canopy management (olive, grape), change in planting/sowing and harvest date (olive, durum wheat), pest and disease management (grape), allocation/choice of cultivation area (grape, durum wheat), use of decision support tools (grape), and crop insurance (durum wheat). In these decision-making contexts, the timely availability of climate information on temperature increase and rainfall variability can be used for developing climate services to effectively support the affected decisions. Although this paper does not provide an exhaustive analysis, the entry points identified can be considered as starting points for informing the development of climate services to further support the adjustment of decision making for the identified olive, grape, and durum wheat cropping systems, as well as similar decision-making contexts beyond those identified here.

9. Mihailescu E., Bruno Soares M., Ponti L., De Felice M., Calmanti S., Dell'Aquila A., Rodríguez D., Cure J.R., Gutierrez A.P., 2020. Exploring the added-value of MED-GOLD climate services across crops and agricultural regions. 6th International Conference on Climate Services (ICCS6), Pune, India, 11-13 February 2020.

Climate change will affect different agricultural areas to different degrees. The Mediterranean Basin is a known hotspot of climate change, where higher than average projected impacts threaten an extremely rich biological and cultural diversity, including important staple crops such as olive, grape, and durum wheat. A major challenge for this region is therefore to increase the resilience of these crops to climate change so as to preserve the associated ecological, economic, and cultural heritage that is key to its sustainability. Climate services have the potential to help address expected climate impacts on agricultural systems such as decreased areas of crop suitability, altered onset of phenological stages, reduced crop yield and quality, and increased incidence of pests and diseases. MED-GOLD - Turning climate-related information into added value for traditional MEDiterranean Grape, OLive and Durum wheat food systems - is a research and innovation project funded by the European Union program Horizon 2020 and aims to support agricultural systems to become more competitive, resilient, and efficient in the face of climate change. The co-production of climate services in MED-GOLD brings together suppliers and users (as project partners) in

the development of three service prototypes: grapes and wine in the Douro region in Portugal, olives and olive oil in the Andalusia region in Spain, and durum wheat and pasta in Italy. The MED-GOLD climate services' potential to be applied to similar crops in other geographical areas as well as to other crops, such as coffee in Colombia, will be investigated. The cumulative added value of MED-GOLD climate services will be also investigated and it will potentially range from enhancing agricultural decision making and management to supporting policy-making at the Mediterranean, European and global levels.

6.3.3. Abstract submitted for Durum wheat sector

10. R. Dainelli, S. Calmanti, M. Pasqui, E. Di Giuseppe, C. Monotti, C. Ronchi, M. Silvestri, C. Chou, N. Gonzalez, R. Marcos, P. Toscano. 'Yield prediction of durum wheat: the added value of MED-GOLD climate services products. 22nd EGU General Assembly, online 4-8 May, 2020, id.20694

Early within-season weather conditions forecast and yield prediction can provide useful information to improve farmers' management decisions and to create a unique opportunity for implementing new solutions to specifically address key aspects of agricultural systems. Within the aims of the EU funded Horizon 2020 MED-GOLD project (https://www.med-gold.eu/), a durum wheat case study has been established to assess an innovative climate service tools for the management of climate risks and to increase yield and reduce potential risk. In this study, the added value of seasonal forecast was assessed by looking at the historical yield data and by comparing the data provided by climate service tool with traditional crop forecasting systems.

For three hot spot areas (Ravenna, Ancona, and Foggia), the skills of the ECMWF-System5 seasonal time-scale forecasting provided through the Copernicus Data Store (CDS) were evaluated as a driver to the crop modelling system DELPHI, to test their added value to durum wheat yield prediction.

Initially, the DELPHI model was run with observed daily weather data from sowing to harvest to obtain the reference yield. Then, yield predictions were calculated at a monthly time step, starting from February 1st and April 1st, by feeding the model with synthetic weather scenarios based on historical observations (dry, average, wet scenario - current mode) and with weather seasonal forecast (new tool) until the end of the growing season. Results for yield prediction on the basis of the current DELPHI System (historical scenarios) and on the basis of seasonal forecast (25 ensembles) were compared against reference yield.

For Foggia and Ancona, in low yielding crop years and 4 months before harvest, the mean yield prediction based on the new DELPHI System tool show lower normalized root mean square error values (nRMSE) than yield predictions based on the current DELPHI system, while the latter performs better 2 months before harvest. The opposite conditions arise for the Ravenna area: lower nRMSE for the current DELPHI system 4 months before harvest and lower nRMSE for the new DELPHI system 2 months before harvest. In high yielding crop years, the new DELPHI system performs better than the current one in all the study areas

both 4 and 2 months before harvest, except in Foggia where the current DELPHI system shows lower nRMSE 2 months before harvest. In general, the availability of unbiased data slightly improved the yield forecast, with the best result achieved for the high yielding crop year in Ancona, where 2 months before harvest the nRMSE dropped from 20.3% (biased) to 9.3% (unbiased). Based on these first promising results this benchmarking framework will be extended over a wider study area and for the full reanalysis temporal coverage.

6.3.4. Abstract submitted for Olive sector

11. Rosati A., Marchionni D., Mantovani D., Famiani F., Ponti L. Intercepted PAR and spatial and temporal distribution of transmitted PAR under high density and super high-density olive (Olea europaea L.) orchards. Trees (Submitted).

We quantified the PAR intercepted by a high density (HD) and a super high density (SHD) olive system by measuring the PAR transmitted under the canopy, from March to September, along transects across the tree rows, at increasing distance from the tree rows, up to the center of the alley. Transmitted PAR in each position was measured every minute from dawn to dusk, then cumulated over the day and the season. The frequencies of the different PAR levels occurring during the day were calculated. The SHD system intercepted slightly less overall PAR than the HD system (0.57 ± 0.002 vs 0.62 ± 0.03 respectively, expressed as a fraction of the PAR incident above the canopy) but had a much greater spatial variability of transmitted PAR, with minimum values under the tree row (PAR = 0.21) and increasing values with increasing distance from the tree row, up to the center of the alley (PAR = 0.59). In the HD system, instead, the transmitted PAR was rather uniform (range: 0.34- 0.43) along the transect. The greater spatial variability of transmitted PAR in the SHD system corresponded to a greater variability in the class frequency distributions of the PAR values occurring during the day, with the more shaded positions being skewed towards greater frequencies of lower PAR values. The much lower PAR level under the tree row in the SHD system (0.21), compared to any position in the HD system, implies greater self-shading in lower-canopy layers, despite overall slightly greater PAR transmission in the SHD system. This lower irradiance resulted from an increased exposure to lower PAR values, mostly in the 50-200 µmol m-2 s-1 class. It is argued that this might reduce the radiation use efficiency of SHD orchards compared to HD ones, even at equal overall PAR interception.

12. Mantovani D., Marchionni D., Ponti L., Rosati A. What light is available for understory crops under high-density and super-high-density olive orchards? Spatial and temporal patterns of transmitted PAR. 5th European Agroforestry Conference, Nuoro, Sardinia, 18-20 May 2020.

Agroforestry can be an opportunity to increase productivity and income in olive orchards (Rosati et al. 2009). In fact, even in intensive olive systems, the maximum oil yield is obtained when the trees intercept

55% of the incident photosynthetically active radiation (PAR) (Villalobos et al. 2006), thus leaving much radiation available for understory crops. PAR is usually the most limiting factor for crops in agroforestry systems (Friday and Fownes 2002) and its availability in the alley is strongly influenced by tree density and canopy size (Rosati et al., 2020). Additionally, the PAR transmitted by the trees is not uniform in the alley, creating areas with different PAR availability. Knowing exactly how the transmitted PAR is distributed in space and time below the crowns, becomes essential to identify the best intercropping strategies and crop positioning.

6.3.5. Abstract submitted for grape and wine sector

13. **Michael G. Sanderson1, Marta Teixeira, Natacha Fontes, António Graça. The Risk of Unprecedented Rainfall in Wine Regions of Northern Portugal. XII Terroir Congress, Adelaide, Australia. 17-18 November 2020.**

Climate is arguably one of the most important factors determining the quality of wine from any given grapevine variety. High rainfall during spring can promote growth of the vines but increases the risk of fungal disease. High rainfall during harvest time (August to October) also bears the potential for severe operational disruption and heavy economic losses. To date, the probability of unprecedented rainfall amounts in spring and the harvest season has not been assessed over northern Portugal, specifically the three wine-growing regions of Vinho Verde, Trás-os-Montes and Porto and Douro DOC. In a situation of higher climatic variability, establishing the probable limits of rainfall variation during critical moments of the vine growth cycle will allow for better readiness of farmers as well as higher resilience of the whole value chain. Observed rainfall totals for northern Portugal were extracted from version 20 of the E-OBS dataset. Seasonal rainfall totals were calculated from a series of 16 month-long hindcasts produced with the Met Office's decadal prediction system (DePreSys3). These hindcasts begin in November of each year, corresponding to the start of each viticultural campaign. Forty ensemble members are available for each start time, providing 1520 simulations of spring and late summer rainfall totals. The probability of an unprecedented rainfall event in spring is 3.0%, and 2.6% in late summer. The chance of a year similar to 1993, with an exceptionally wet spring and late summer, is very small.
Seasonal rainfall totals considerably higher than any observed are possible in the current climate. The chance of another year similar to 1993, when both seasons were exceptionally wet, is very low. The use of the modelled data means uncertainty in future extreme rainfall estimates is considerably reduced. A year with rainfall equal to the highest observed amounts in one of these two seasons could be expected to occur once in the next three decades.

Significance and impact of the study: This study is the first to assess the probability of unprecedented rainfall extremes over northern Portugal, allowing for a better estimate of the inherent risk. The results

help inform the need for costly adaptation investments, such as better availability of spraying machinery and labour, high-gauge drainage, landslide controls or even abandonment of exposed vineyard areas.

14. Dell'Aquila, A. and MED-GOLD Wine Service Team: Turn climate information into value for the Mediterranean wine sector: the MED-GOLD potential, EGU General Assembly 2020, Online, 4–8 May 2020, EGU2020-7046, https://doi.org/10.5194/egusphere-egu2020-7046, 2020.

MED-GOLD is an EU-funded Horizon 2020 project (https://www.med-gold.eu/) whose main objective is to demonstrate the proof-of-concept for climate services in agriculture by developing case studies for three staples of the Mediterranean food system: grapes, olives and durum wheat. MED-GOLD will propose climate services deploying forecast information at seasonal (next 6 months) and long-term (next 30 years). This information will be provided at higher spatial resolution than what is currently available. To provide the highest value for decision-making, the services will be co-developed with professional users from each sector.

For the wine sector, the project objective is to use the most recent state-of-the-art climate models outputs to produce user-oriented predictions of essential climate variables, bioclimatic indicators and ad-hoc implemented compound risk indices. All of these indices are relevant for viticulture at large scales, and more specifically for the MED-GOLD focus region of the Douro valley (Portugal). The indices will be readily available for users in the grape and wine sector under several different formats and visualizations, allowing for easy, quick and seamless integration into critical decision-making. Timely warnings of when climate change might impose a disruptive pressure upon wine production systems offers stakeholders a chance to act proactively both at seasonal (operational campaign planning) and decadal (strategic business planning) time-scales, making the wine sector more resilient to the impacts of climate change.

7. EXPLOITATION OF RESULTS

The aims of compilation are to inform and connect end-user communities. This is important because there is often insufficient awareness of vulnerability to climate change, and climate services in different sectors have been hindered by a lack of relevant products and services offered by the scientific community[RD.7] Informing stakeholders through publications, networking and other communication channels can increase awareness of their vulnerability and climate service tools that could potentially help them. Communication and dissemination also increases scientific capacity among climate researchers, users and providers; not only in the region of the study but also in the regions where climate services are less developed. It can also broaden climate service applications in the food sector by introducing added value in the pilot services and encouraging the wider community to adapt and exploit the climate services. Furthermore, since climate service is a relatively new market, introducing the added value of climate services increases the market uptake of climate services, which has been confirmed in literature [RD.8]

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