The MED-GOLD project: Advanced user-centric climate services for higher resilience and profitability in the grape and wine sector

A. Graça[1] and MEDGOLD Consortium[2]

[1] SOGRAPE VINHOS SA, Rua 5 de Outubro 4527, 4430–852 Avintes, Portugal
[2] The MEDGOLD Consortium is integrated by the above-mentioned entity and:

- Agenzia nazionale per le nuove Tecnologie, l'energia e lo sviluppo económico sostenibile (ENEA), Roma, Italy
- Barilla G. & R. Fratelli S.p.A., Parma, Italy
- BeeToBit SRL., Cagliari, Italy
- Barcelona Supercomputing Centre (BSC), Barcelona, Spain
- Consiglio Nazionale di Ricerca – Istituto di Biometeorologia (CNR-IBIMET), Firenze, Italy
- DCOOP S.C.A., Antequera (MA), Spain
- EC2CE, Sevilla, Spain
- GMV Aerospace and Defence S.A. (GMV), Madrid, Spain
- HORTA S.r.l., Piacenza, Italy
- Joint Research Council, Ispra, Italy
- Met Office, Exeter, UK
- National Observatory of Athens, Athens, Greece
- Universidad Militar de Nueva Granada, Bogotá, Colombia
- University of Leeds, Leeds, UK

Abstract. Agriculture is primarily driven by weather. Forecast climatic conditions will further increase its vulnerability to crop failure and pest damage. Nowhere will this have consequences as dramatic as in the Mediterranean Basin. The challenge here is how to increase resilience of this complex ecological, economic, and cultural heritage in an era of decreasing resources and climate change. Climate services have the potential to support the transition towards a climate-resilient and low-carbon society. The MED-GOLD project will demonstrate the proof-of-concept for climate services in agriculture by developing case studies for three staples of the Mediterranean food system: grape, olive and durum wheat. The new climate services for agriculture developed by MED-GOLD will provide targeted information to companies that will allow them to act over longer time periods (months, seasons or even decades into the future) that go beyond the traditional 2–5 days provided by current weather forecasts. The cumulative benefit of MED-GOLD will range from enhancing agricultural management to supporting and informing policy-making at the Mediterranean, European and global levels. This is because olives, grapes, and durum wheat are grown across the globe and produce the raw materials for global food commodities such as olive oil, wine and pasta.

1. Introduction

Agriculture is perceived as one of the economic sectors where investments in climate services are likely to make the biggest impact [1]. Decision making processes in the agriculture sector can still, largely, be optimized and better adapted to natural and anthropogenic fluctuations and changes in the climate system. For example, average crop losses due to pests range between 26.2% and 40.3% worldwide [2]. As such, pest problems are a substantial source of uncertainty in agriculture with climate being their main driver. Similarly, the sub-optimal use of fertilizers can significantly affect the carbon footprint of many production chains, thereby driving primary production against important EU targets in terms of the reductions of greenhouse-gas emissions.

In the wine sector, there is a well-established notion that a wine's quality is inextricably linked to the environment of its production, including soil, climate, topography, and the history and culture of a place [3]. Climate is arguably the most important determining factor of the quality of wine for any given grapevine variety. Climate change is affecting wine production in all parts of the world, from rapid loss of viability right through to highly beneficial aspects that increase suitability. An example at one end of such impacts is the recent expansion in wine production in the United Kingdom and Denmark, where previously the climate was relatively inhospitable for growing of wine grapes. If the wine industry in any

part of the world wishes to survive and thrive in the future, it will need to adapt to the challenges of climate change. Under a changing or changed climate it will be important for individual producers to decide whether "business as usual" remains a viable and sustainable option, or if changing their style of wine will allow for improved value through maintaining and enhancing consumer perception of the new quality of wine [4].

Ground-breaking findings in the field of climate modelling [5–7] have led to high expectations about the possibility of using climate predictions to improve decision making in the long-term (seasonal timescales and beyond) planning of human activities. However, climate data and climate information at different spatial and temporal scales have not yet been exploited to their full potential and may have a significant impact in improving key decisions across different sectors [8–10]. While potentially relevant tools, data and methodologies have been developed, less effort has been dedicated to implement and test the usability of the climate services in key decisions to generate their full impact on the ground. Consequently, the potential benefits of using climate services in the agriculture sector is not yet fully understood. The impact of climate services in the agriculture sector needs to be demonstrated with real-world pilots that can illustrate the usefulness and usability of these services in this sector.

2. Objectives

The central idea of the project MED-GOLD is to co-design climate services for agriculture by focusing on three crops that are typical of the Mediterranean area: olives, grapes and durum wheat. A preliminary market analysis, comprehensive mapping of existing initiatives and networks in the three sectors, along with a summary of the overall quality of the climate data available will enable better framing of novel pilot services. A common framework will be adopted to develop innovations in the three sectors. The pilot services will be the result of a co-design process where three lead actors in the food industry of each sector will guide a team of climate scientists, agronomists and economists in developing innovative solutions for managing their climate related risks and improve their decision-making processes. The co-development will assure continuous interaction and feedback with the users of the pilot services. Existing modelling tools already in use by these actors for the provision of agro-meteorological services will be enhanced and adapted to provide information at different climate timescales – from seasonal to decadal timescales and beyond. The industrial partners of the consortium will additionally play a leading role in catalysing the interests from other stakeholders and organisations in the respective sectors.

The general objective MED-GOLD is to make European agriculture and food systems more competitive, resilient, sustainable and efficient in the face of climate change, by using climate services to minimize climate-driven risks/costs and seize opportunities for added value. MED-GOLD will develop climate service prototypes that will assist wine businesses in managing risk within the framework of their medium- and long-term business strategies. Two important activities in winegrowing will be targeted: (i) Spring grapevine protection against diseases and pests, whose planning will benefit from the availability

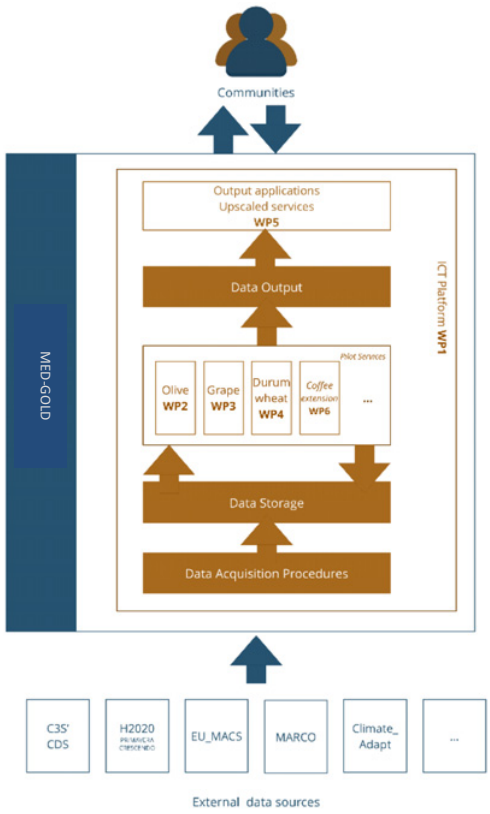

Figure 1. Information and communication platform scheme.

of seasonal forecasts with appropriate temporal and spatial resolutions; and (ii) plantation of a new vineyard, whose structural choices of site, density of plantation, training system, requirement for irrigation, scion and rootstock varieties, among others, will profit from the existence of long-term predictions, allowing the grower to anticipate, several decades into the future, climatic factors affecting its profitability.

3. Methodology

MED-GOLD is focused on a systematic and user-driven transformation of climate, impact and economic data into information and knowledge that can inform and support users' decision-making in specific pilot services. These pilot climate services will be co-developed following the same user-centred methodological framework, regardless of the intrinsic differences of the three sectors (olives/olive oil; grape/wine; durum wheat/pasta).

All the pilot services will rely on a tailor-made information and communication (Fig. 1) platform, consisting of a cloud-based infrastructure whose role is to provide a centralised platform to collate basic technological tools for all the pilot services that will be developed during the project. Functionally, there will be three main layers to this platform: the first one will deal with data acquisition, and will be responsible for importing and normalising data from external sources, including the Copernicus climate data store, needed for all the models, simulations and algorithms of the pilot services. Both the externally acquired data and results computed by the models themselves will be managed by the data storage layer, which will coordinate the storage of data on various physical media (e.g.: SQL, Graphical representations, File

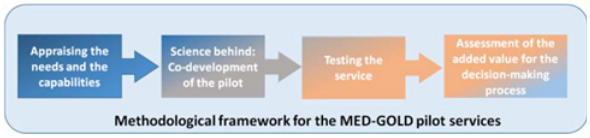

Figure 2. The MED-GOLD methodological framework.

systems, Object storage) and will also provide methods to store, search and retrieve stored information. The third layer, data output, will provide a set of tools, such as APIs and automatic data exports, which will allow communities and applications to be built upon the results of the project.

Each pilot service will deal with specific questions and associated decisions identified with industrial partners across different timescales (from seasonal to longer timescales). A key aspect in the co-development of the pilot services is to manage the expectation of end-users. A user-driven common methodological framework will be adopted to co-develop pilot services. This framework will exploit the knowledge generated under previous initiatives (EU FP7 projects CLIM-RUN and EUPORIAS). We will follow the climate services protocol initially drafted in CLIM-RUN5 and add further improvements, taking into account more recent initiatives on climate services (EUPORIAS, C3S SECTEUR and all the SISs). The methodological framework (Fig. 2) is composed of four steps:

1. Step 1: Appraising needs and critical decisions
2. Step 2: Co-developing the specific service tools
3. Step 3: Testing the specific service tools
4. Step 4: Assessment of the added value for the decision-making process.

All the main outcomes will be reported to the MED-GOLD end users' community. A significant sample of the main players, not directly involved in the development or testing of the pilot services of services for the three sectors, will be engaged from the beginning of the project. They will be continuously updated and informed on the steps forward of the pilot and on the methodological framework adopted. Building trust over time into the project community will facilitate the future roll-out strategy to discuss the pilot services developed for the three sectors within the MED-GOLD community. This process will allow for validation of the services and exploration of their potential applicability and upscaling in the wider community.

4. Timeline

The project started in December 2017, and is currently in the first of 4 years of duration. During 2018, most of the work will concentrate in sector appraisal, assessing available climate information, developing the information and communication platform and building sectorial communities around the project. Development of pilot services started in 2018 and will continue into the first half of 2020. Validation of the developed services is scheduled to begin in 2019 and last until the first quarter of 2021. However, engagement with sectorial communities for dissemination of the pilot services commenced in 2018. Assessment of replicability of pilot services into different markets (sectorial and geographic) is scheduled to be executed between 2020 and 2021, as well as showcasing stakeholders' experiences and hosting open summer trainings.

5. Expected impacts

Building on previous experiences, the ambition of MED-GOLD is to create a new paradigm of climate informed decision-making processes within the agri-food chain. The example of the MED-GOLD industrial partners will be used as an example of best practice to catalyse the interest in climate services and stimulate the demand with other users. Ultimately, the ambition is to reach the wider European agricultural sector and society at large.

By 2050 it is thought that there will be an extra 3 billion people to feed, while agriculture will likely have to face increased numbers and types of pests with less predictable behaviours and migratory range, owing to a changing and more variable climate [11]. With mandatory integrated pest management (IPM) in the EU since 2014, this challenge will have to be tackled by replacing pesticide inputs with knowledge and management inputs, especially holistic knowledge on how crop-pest systems respond to climate variability and change. Climate services developed under MED-GOLD will be important in tackling this challenge, building on and complementing recent EU efforts such as the PURE project (Pesticide Use-and-risk Reduction in European farming systems with Integrated Pest Management) [12].

One of the targets of MED-GOLD is the promotion of a more climate-informed community for the European agriculture sector, with specific attention to the three main sectors addressed by this proposal. To reach this target, there will be emphasis on activities to engage the wider community and communicate results. Three different types of activity are planned during the duration of the project: dissemination through attendance at international conferences, communication to target audiences to engage communities, and exploitation to foster the development of services and products based on the project's outcomes and using them in further research activities.

For the wine sector, a more consequential use of climate services with proper understanding of forecasts and associated uncertainties is expected to provide better strategic planning and higher profitability deriving from educated decisions in terms of choice of vineyard sites, varieties and business models. Grape and wine production should become more resilient, decreasing the use of plant protection products and water, and better planning of farming operations. Even if the pilot services do not address other processes of the wine industry, carry-over of results can be anticipated for sizing of long-term facilities such as wineries, warehouses, wastewater and recycling, transport logistics, hosting and marketing campaigns, among others.

Finally, the MEDGOLD user-centric approach, deploying existing climate knowledge as climate services which are easy to integrate and able to add value for a global and relevant economic sector as the grape to wine value chain, will bind climatologists and model scientists to grape growers and winemakers. Both communities will benefit from insights, developments and innovations that make climate information more readily usable and value oriented.

6. Conclusion

MED-GOLD will demonstrate a high level of innovation by co-developing with end-users climate services for the current challenges of grape and wine production in face of climate variability and change. It will focus on building a community first around the sector's stakeholders with the aim to develop business opportunities and support resilience of production systems.

Grape and wine stakeholders, public and private, in Europe and elsewhere are invited to follow the project's development through its webpage (`https://www.med-gold.eu/`) and to join the moderated discussions in its online forum (`http://forum.med-gold.eu/`).

References

[1] C. Vaughan, L. Buja, A. Kruczkiewicz, L. Goddard, Clim. Serv. **4**, 65 (2016)
[2] E.-C. Oerke, J. Agr. Sci. **144**, 31 (2006)
[3] S. Charters, *Wine & Society: The Social and Cultural Context of a Drink* (Elsevier, Oxford, 2006)
[4] M. Gishen, A. Graça, G. Jones, "*Proposal for the Development of a Framework for a Globally Relevant Wine Sector Climate Change Adaptation Strategy*" in Proceedings of the 11th International Terroir Congress (McMinnville, Oregon, USA, 2016)
[5] N. Dunstone, D. Smith, A. Scaife, L. Hermanson, R. Eade, N. Robinson, M. Andrews, J. Knight, Nat. Geosci. **9**, 809 (2016)
[6] E. Palin, A. Scaife, E. Wallace, E. Pope, A. Arribas, A. Brookshaw, J. Appl. Meteor. Climatol. **55**, 325 (2016)
[7] A. Scaife, A. Arribas, E. Blockley, A. Brookshaw, R. Clark, N. Dunstone, R. Eade, D. Fereday, C. Folland, M. Gordon, L. Hermanson, J. Knight, D. Lea, C. MacLachlan, A. Maidens, M. Martin, A. Peterson, D. Smith, M. Vellinga, E. Wallace, J. Waters, A. Williams, Geophys. Res. Lett. **41**, 2514 (2014)
[8] R. Clark, P. Bett, H. Thornton, A. Scaife, Environ. Res. Lett. **12** (2017)
[9] T. Gunda, J. Bazuin, J. Nay, K. Yeung, Environ. Res. Lett. **12** (2017)
[10] M. Capa-Morocho, A. Ines, W. Baethgen, B. Rodríguez-Fonseca, E. Han, M. Ruiz-Ramos, Agr. Syst. **149**, 75 (2016)
[11] A. Birch, G. Begg, G. Squire, Jour. Exp. Bot. **62**, 3251 (2011)
[12] F. Lescourret, Crop Prot. (2016)