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Empowering communities through seasonal forecasts use: a lesson learned from the Euro Mediterranean 2021-2023 drought event

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In the period between 2021 and 2023, the Euro-Mediterranean region experienced a series of significant thermo-pluviometric anomalies. In particular, in the central Mediterranean, the Copernicus Climate Change Service identified exceptional temperature anomalies and a complex and intense drought, also highlighted in the "European State of the Climate (ESOTC)" reports. Prolonged periods characterised by extreme weather events pose a serious threat to both society and human activities, even in advanced countries.

Water scarcity and water resources management play a prominent role among the climatic threats, as their impacts represent the main pressure mechanisms for human beings, ecosystems, and many human activities. Therefore, it becomes imperative to develop advanced systems for forecasting and anticipating climate variability to provide crucial information to decision-makers and users, facilitating preparation for mitigation actions. Addressing this challenge requires the implementation of operational predictive systems on a seasonal scale that are reliable, salient, and easily adaptable, aiming to enhance economic and societal resilience. To this end, the Drought Observatory (DO) of CNR IBE, a web-based climate service open to the public, has developed and maintained a prediction system based on various components: a seamless prediction system based on the European model SEAS5, coupled with a bias adjustment algorithm; a Non-Homogeneous Poisson process trend analysis of individual drought severity classes; and an evaluation of vegetation stress trough indices calculated from both atmospheric variables and remotely sensed quantities. The DO has been conceived to share both the outcomes of ever-evolving scientific research and a structured set of scientific information. Tailored to different levels of complexity, this information aims to address the informational needs of both technical experts and decision-makers, as well as a wider audience and media representatives.

The DO develops these components in close collaboration with stakeholders and users engaged in institutional activities and national and international research projects. This interaction strengthens decision-making processes for adapting to meteorological and climatic risks and adversities.

An integrated approach, that relies on "converging evidence", has been adopted to achieve an even more pertinent level of information. The 2021-2023 period, characterized by extreme climatic

conditions, has been studied as a rare multiyear event to assess the effectiveness of seasonal-scale anticipation systems for climate anomalies. Moreover, this timeframe proves particularly valuable for understanding and addressing challenges associated with climate change.

Verification analysis shows that seasonal forecast skills vary over time and geographical areas. It is thus possible to identify windows of opportunity for specific tasks in cooperation with users. Within this framework, bias-corrected seasonal forecasts provide valuable supporting information for water resources management and decision-making processes. Throughout the drought period from 2021 to 2023, the Drought Observatory played a pivotal role, extensively utilized by national and international media to disseminate precise information regarding the drought trend in Italy. This underscores the crucial requirement for timely and science-based data to enlighten the broader public.