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From seasonal forecast skill to end-user economic benefit: the case of the Lake Como

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Recent increase in spatiotemporal model resolution, availability of data/monitored variables, improvement in initialization procedures, and more accurate representation of physical processes contributed in advancing the quality of weather and climate services. State-of-the-art meteorological and hydrological forecast services are becoming more and more skillful over seasonal timescales, potentially representing an asset for informing strategic decisions in different economic sectors. Such services can play a key role in irrigated agriculture for supporting crop choices and irrigation scheduling decisions, which strongly depend on the expected hydro-meteorological conditions. However, although the accuracy and reliability of forecast services depend on the set up of the models that generate the forecasts, their (added) value also depends on how decision makers use the provided information in operational contexts.

In this work, we contribute a novel framework to assess the value of weather and climate services, by extending traditional forecast quality assessment methods with estimates of the potential end-user economic benefit from using forecast information. We also explore the sensitivity of the potential economic benefit on both the model set up and decision maker behavioral factors. The framework is demonstrated on the Lake Como system (Italy), a regulated lake primarily operated for flood protection and irrigation supply.

Our framework relies on the following integrated modeling chain: 1) lake inflows are produced from bias adjusted ECMWF System 4 seasonal forecasts used as input to the continentally-calibrated E-HYPE hydrological model; 2) this information is then used for conditioning the daily lake operations; 3) the resulting lake releases finally feed an agricultural model to estimate the net profit of the farmers in the downstream irrigation district. The whole chain was run for a 12-year period running from 1996 to 2007, including a fairly balanced number of normal, wet, and dry agricultural seasons.

Results suggest that, on average, informing the Lake Como operations based on ECMWF System 4 coupled with E-HYPE hydrological forecasts allows gaining about 4% of farmers' profit with respect to a traditional operating policy conditioned on the modelled inflow climatology. This gain rises up to 16% during intense drought episodes. Moreover, this value is shown to be particularly sensitive to climate forcing inputs, but also on how the lake operator uses the forecast information depending on the different perceptions of risk and uncertainty.