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Detection of meteo-hydrological trends and water resources impacts at the basin scale

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Trend detection is a classical topic of time series analysis and has gained renewed interest in the last years in climate change research.
When dealing with hydrological time series, trend detection is made more complex by the seasonality and the interannual variability that characterize natural catchments. Furthermore, the impacts of detected hydrological trends on water resources at the catchment scale is a relatively less explored issue, although of high relevance for stakeholders and decision-makers. In this study we address such topics investigating the relation between hydro-climatic trends and their impacts on water resources at the basin scale by application to the regulated Alpine lake Maggiore, at the border between Switzerland and Italy. This case study is particularly interesting because of the relevance of the socio-economic component in the system, especially the issues of flood control and downstream irrigation supply, and the high seasonality and interannual variability of the climatic and hydrological system. We propose several graphical tools to effectively visualize the results of traditional trend detection methods like the Mann-Kendall test and the Sen method, and a novel tool, named Moving Average over Shifting Horizon (MASH), which allows to simultaneously tackle seasonality and interannual variability. We also show and discuss how these tools can be applied to quantify the impacts of the detected meteo-hydrological changes on water resources at the basin scale.
In our case study, numerical results demonstrate that significant hydrological trends have occurred in the last 25 years, and that they can be reasonably ascribed to changes in the meteorological regime. The consequences of hydrological changes on water resources, namely flood protection along the lake shores and downstream irrigation supply, are less clear, possibly because of non-linearity and threshold effects.