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Climate Change and extreme precipitation events: from observation to forecasts.

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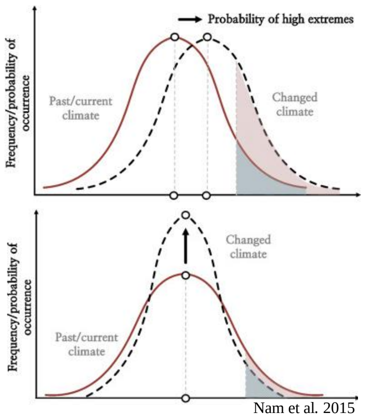
Climate change, precipitation extremes, convective events

Climate change has been, and still today is, one of the most relevant and debated topics for the scientific community. If no action will be taken to face the climate change, strong consequences for the Earth may occur. As an example, an increasingly warm climate could result in an increase of the occurrence of longer and more intense droughts in the 21st century with relevant implications in water availability for human, vegetation, and agriculture. At the other side of the spectrum, an increasing trend in the magnitude and frequency of heavy rainfalls could lead to floods and, consequentially, to fatalities and economic damages. The Mediterranean region has been often referenced as one of the most responsive regions to climate change (Giorgi, 2006), so much to be defined as a primary hotspot of climate change. Also, the last report from the Intergovernmental Panel on Climate Change has highlighted the Mediterranean as one of the most vulnerable regions in the world to the impacts of global warming (IPCC, 2019). One of the most debated points, still today, is whether these changes have led to an increase in frequency and magnitude of heavy rainfall events over the Mediterranean area in the last years.

The research activity will be focused on the thorough analysis of intense precipitation events, with particular attention to convective ones, as well as the influence that climate change may have on them. Due to the complexity of the topic, the research will be divided into three consecutive steps, and it will be implemented first for Sicily and then for the Mediterranean area. In particular, the first part will be reserved to the identification of climate change signatures, by collecting and understanding all the proofs that have been collected over the years. During this phase, it will be essential to elaborate all the available hydrological data, such as “at-site” historical time-series, but also radar and satellite imagery products. Starting from the data, new trend detection techniques, such as quantile regression (Koenker, 2005), will be tested, aiming to verify also whether convective events are increasing in a significant manner under the stress of climate change. This first step of the research will be propaedeutic for the second one, in which the concept of stationarity for the derivation of the Intensity-Duration-Frequency curves will be relaxed (Cheng & AghaKouchack, 2015). The IDF curves are necessary to set up any hydrological model, and so, to derive the hydrological risk. With this regard, a changing climate may lead to an increasing frequency of extreme events, resulting in an underestimation of their effect, especially for the convective ones. Finally, the third phase of the research will focus on forecasting, aiming to study how the IDFs may vary within future climate model projections. In particular, by using the Representative Concentration Pathways (RCP) and the Regional Climate Model (RCP), an attempt to extend the temporal *downscaling* (Forestieri et al., 2018) to the sub-hourly duration will be made.

Cheng, L., AghaKouchak, A. Nonstationary Precipitation Intensity-Duration-Frequency Curves for Infrastructure Design in a Changing Climate. Sci Rep 4, 7093 (2014).
Forestieri, A., Arnone, E., Blenkinsop, S., Noto, L. V., & Fowler, H. (2017). The impact of climate change on extreme precipitation in Sicily. *Hydrological Processes*.
Giorgi, F. and Lionello, P. (2007) Climate change projections for the Mediterranean region. *Global and Planetary Change*, **63**, 90– 104.
IPCC. (2019) *Climate Change and Land: An IPCC Special Report on Climate Change, Desertification, Land Degradation, Sustainable Land Management, Food Security, and Greenhouse Gas Fluxes in Terrestrial Ecosystems*, In press.
Koenker, R. (2005) *Quantile Regression*. Cambridge: Cambridge University Press.

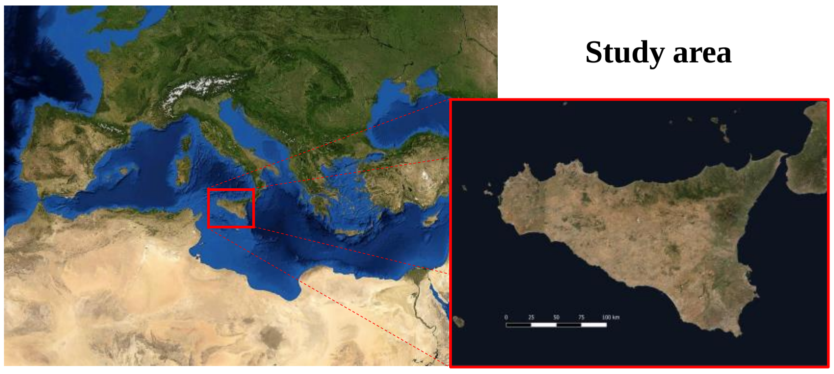
Climate Change



Nam et al. 2015

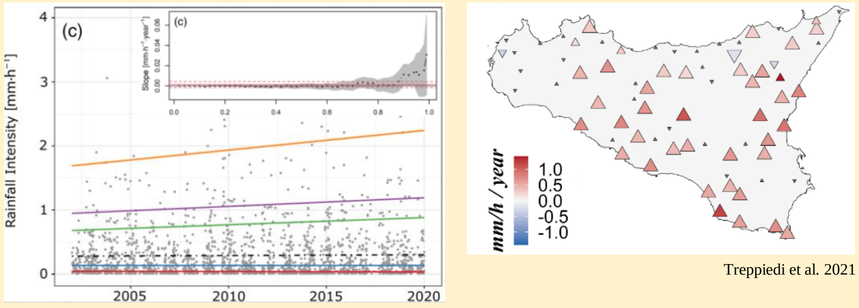
Consequences

Study area



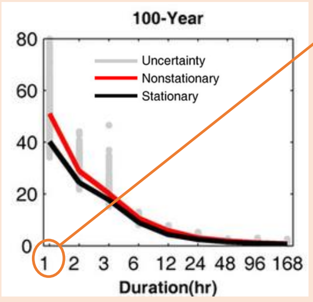
Research activity

1. Climate change signature and trend detection



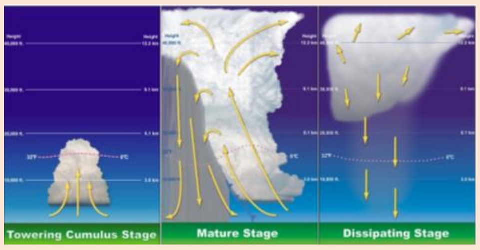
Treppiedi et al. 2021

2. Non-stationary IDF curves

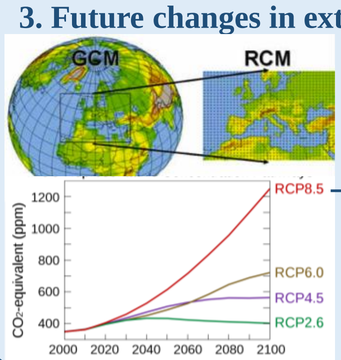


Cheng & AghaKouchack, 2015

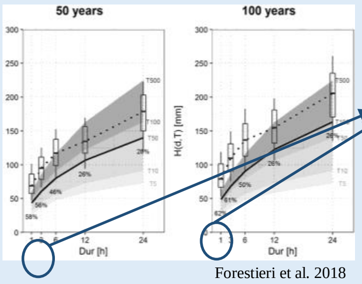
move to sub-hourly durations and model **convective** events



3. Future changes in extreme rainfall events



2050-2100



convective events

Forestieri et al. 2018