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Characterization of extreme meteo-hydrological events in the Alpine Region: historical picture and future scenarios

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Introduction and aim of the research project

In the **European Alps**, climate change has determined changes in extreme precipitation and river flood events, which impact population living downstream with increasing frequency.

The objectives of our work are:

1. To determine what types of precipitation extremes and river flood events occur in the Alpine Region, based on their generating mechanisms (e.g., frontal convergence storms, convective storms, snow-melt floods, rain-on-snow floods, short and long rain floods, flash floods, ...).

2. To determine the spatial and seasonal distribution of these event types (e.g., their dependence on elevation, geographical location, catchment size, etc.) and how precipitation extremes relate to the floods they produce (e.g., role of snow precipitation and accumulation).

3. To determine whether the event type distribution is changing and may change in the future (e.g., due to climate change).

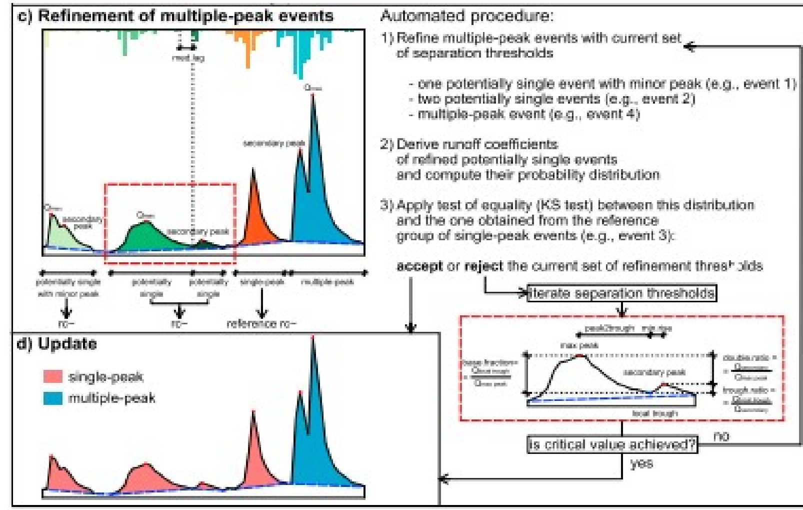
Methodology and Data

We will compile and analyze historical time series of precipitation and discharge in order to identify events in terms of intensity, duration and spatial extent.

We will use the ETCCDI Indices as measure of the precipitation distribution and hydrograph separation techniques for flow events, following the methodology of ***Tarasova et al. (2018)***.

We will then characterize the different event types in terms of the generation mechanisms, by analyzing their frequency and magnitude in different locations and time of the year.
The aim is to determine whether clusters exist, by applying automatic techniques (e.g. K-means clustering algorithm).

Finally, we will correlate the occurrence of precipitation and flood event types with climate indices related to large scale atmospheric circulation, such as Atmospheric Blocking, NAO, etc. (*Ciccarelli et al. 2008*).
This will be useful for the projection of future storm and flood scenarios.



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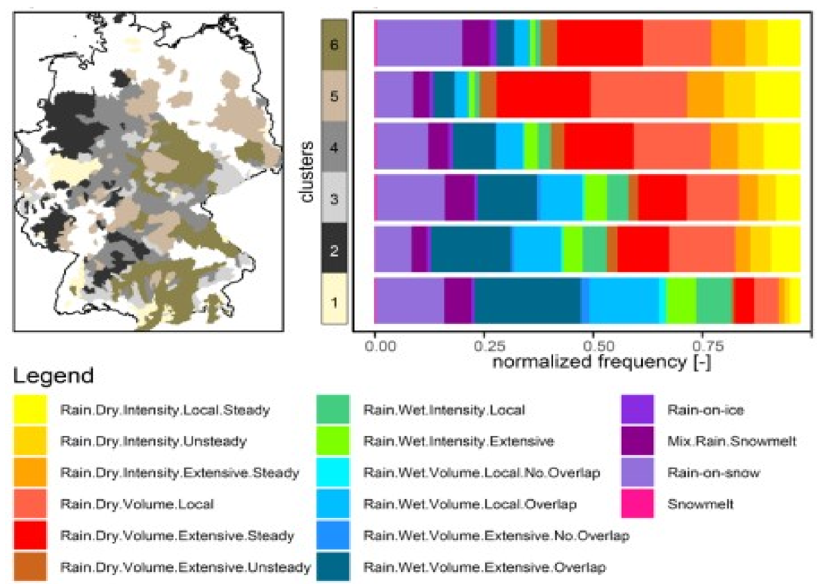
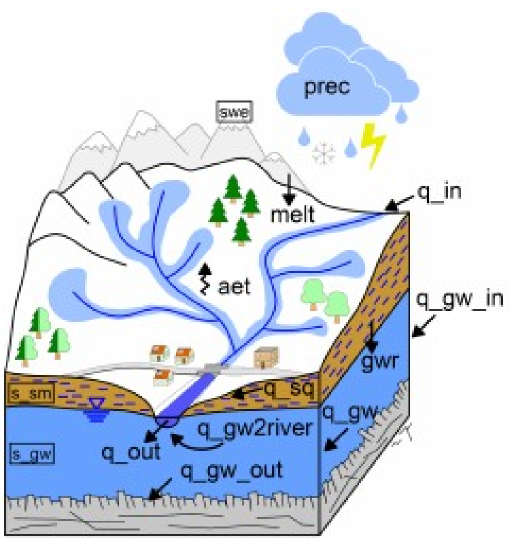


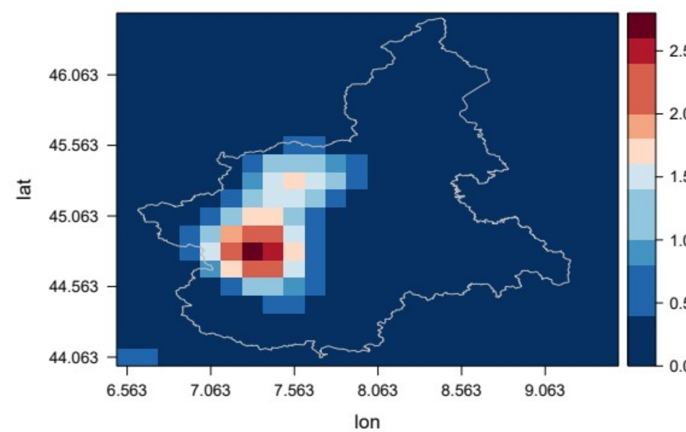
Methodology and Data

- First step: data homogenization in Piedmont by comparing statistics (mean, variance, maxima) of the station-based time series with the North Western Italy Optimal Interpolation (NWIOI) dataset by ARPA Piemonte and reanalysis datasets by ECMWF (ERA5, ERA5-Land).

- Second step: implementation of a distributed rainfall-runoff model at the daily timescale, through calibration at the regional scale ***(Merz et al. 2020)***.

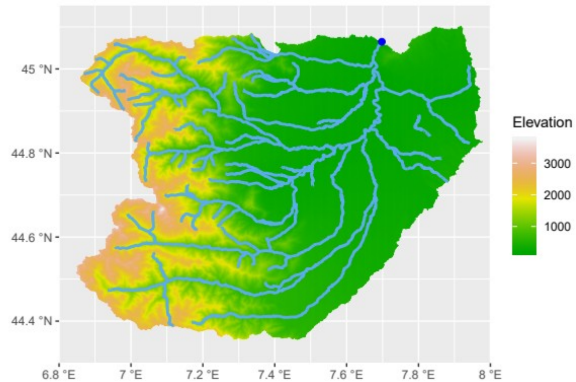


Parameters:	
TM	threshold temp of rain & snowfall
DDF	degree day factor
S_SM_MAX	max. soil moisture storage
B_SM	non-linearity of runoff generation
B_AET	non-linearity of act. evaporation
B_GWR	non-linearity of groundwater recharge
GWR_MAX	max. groundwater recharge
K_SQ	storage coeff. fast runoff reservoir
B_SQ	power coeff. fast runoff reservoir
K_GW	storage coeff. slow runoff reservoir
B_GW	power coeff. slow runoff reservoir
S_GW_MAX	max. groundwater storage
B_GW_Q	power coeff. GW contr. to river runoff
K_RIVER	storage coeff. river routing
B_RIVER	power coeff. river routing

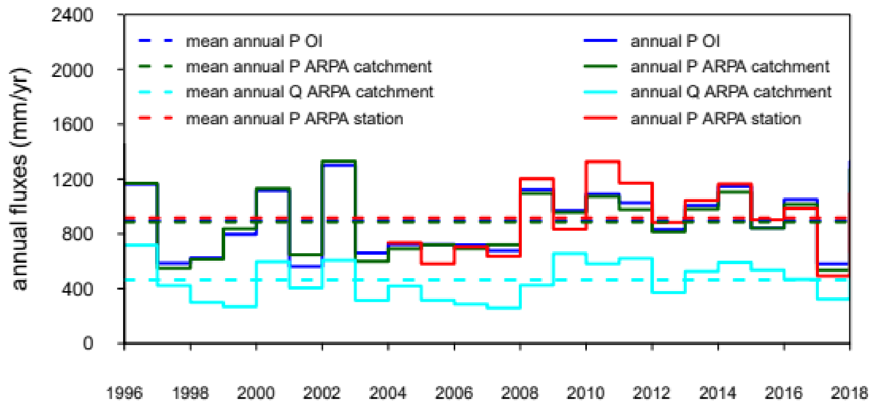


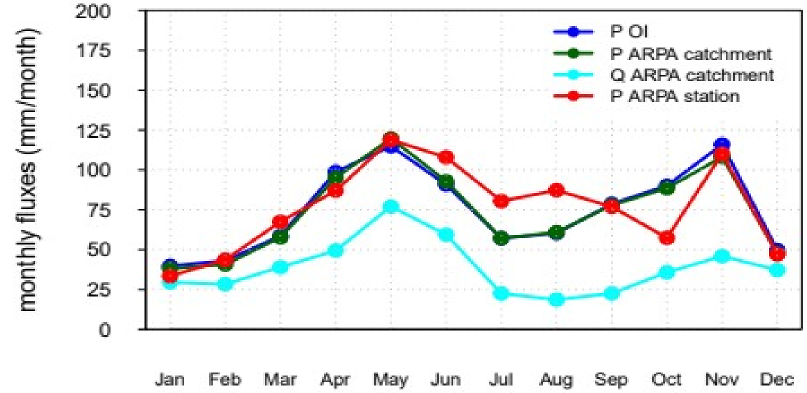
Some preliminary results: Po and Dora Riparia river catchments

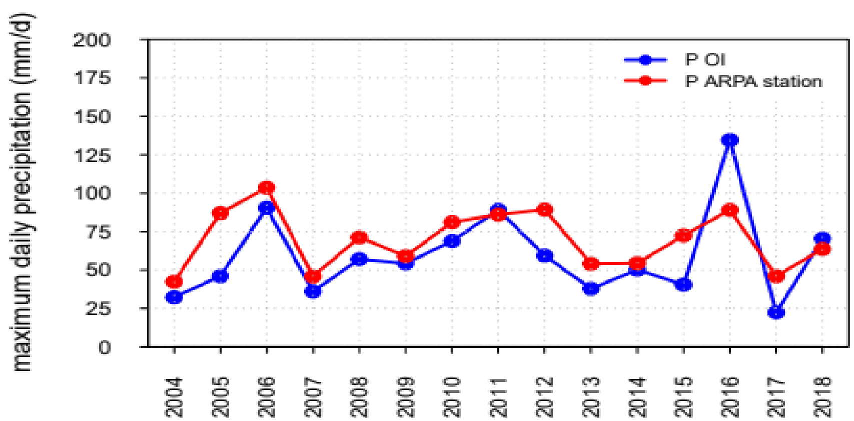
- Interannual variability and seasonality of precipitation (P) and runoff (Q) (in mm/yr, derived from streamflow considering catchment area)
- Precipitation annual maxima



Po catchment, at Torino Murazzi





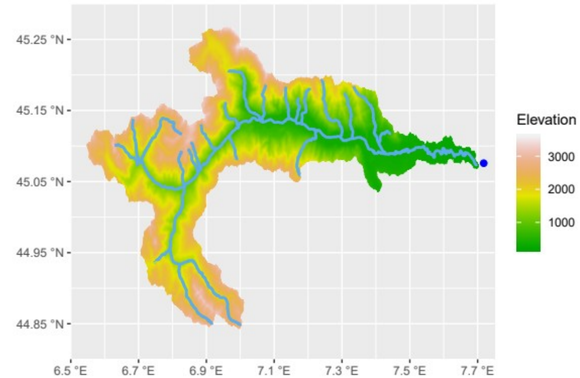


Comparison between the Optimal Interpolation dataset, the catchment aggregated data and the station-based timeseries of Via della Consolata, Torino.

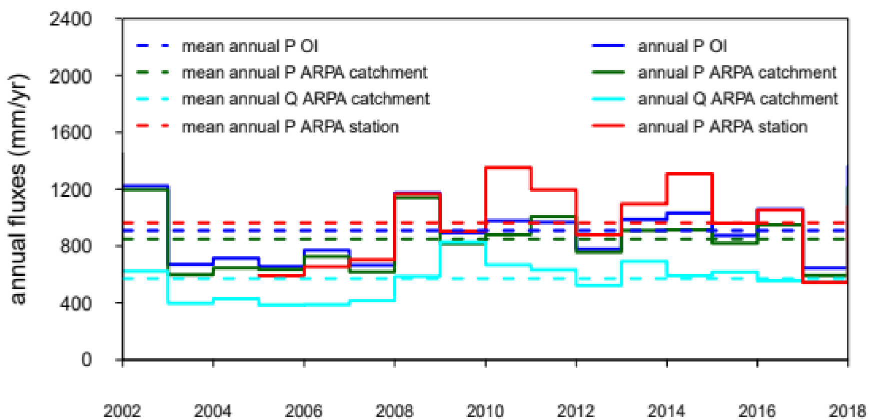
The OI dataset resolution has been increased from 0.125° to 0.0125° to improve the accuracy of raster clipping using the catchment shapefile.

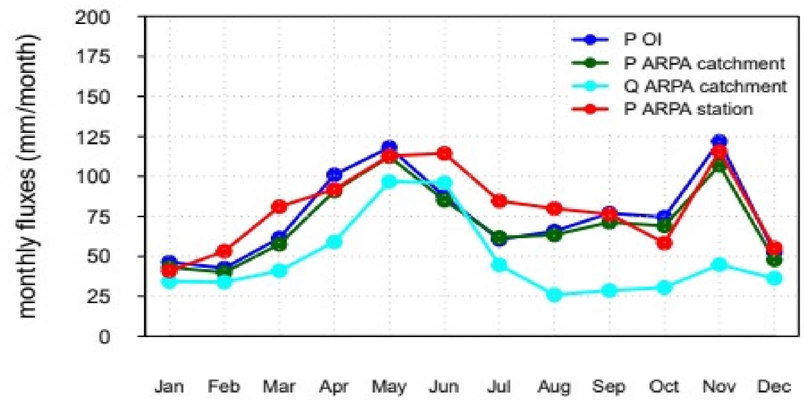
- Interannual variability and seasonality of precipitation (P) and runoff (Q) (in mm/yr, derived from streamflow considering catchment area)

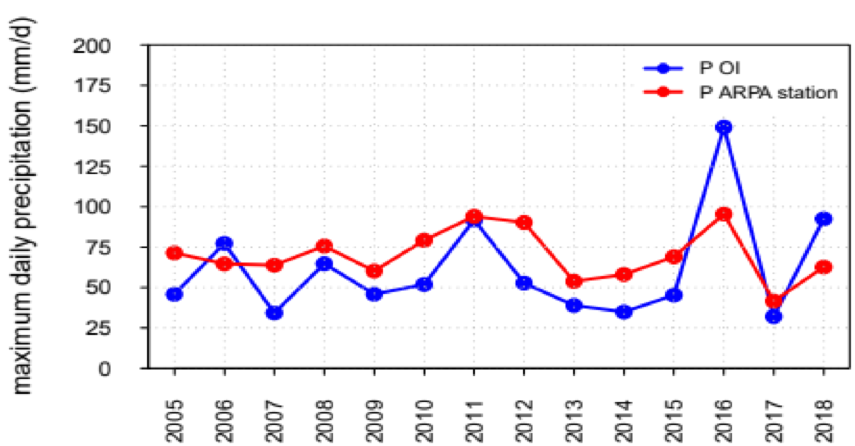
- Precipitation annual maxima



Dora Riparia catchment, at Torino Ponte Washington







Comparison between the Optimal Interpolation dataset, the catchment aggregated data and the station-based timeseries of Torino, Giardini Reali.

- The different datasets show similar interannual variability and seasonality of precipitation (2 peaks, in May and November)
- Station-based timeseries show higher annual maxima

Conclusions

The research results can be relevant both from a scientific perspective, to better understand storm and flood regimes and their change in the Alpine Region and, from an applied perspective, to better evaluate the risk associated with the occurrence of extreme events.

For further information or feedback contact me:

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