Convective rains trends over Piemonte Region

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ABSTRACT

The aim of the work is to identify the trend of the convective rains over Piemonte region during the last 30 years. The task is pretty difficult because first of all the definition of convective rain is not unique in literature. Secondly, the ARPA Piemonte rain gauges network has had a remarkable increase during 30 years, from around 50 stations in 1989 to over 300 from 2009 to date.

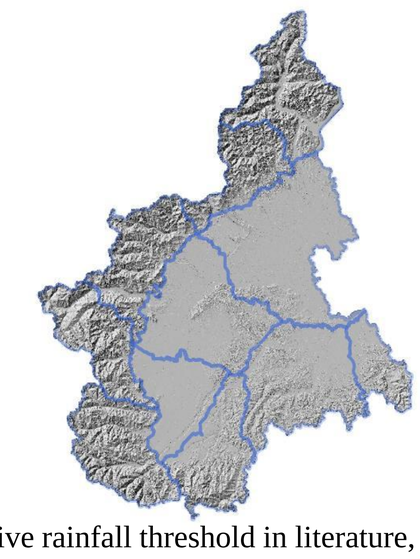
A convective rain event was defined as the overcoming of a threshold of 10 mm in 20 minutes, over an alert area (Piemonte region is divided in 11 alert areas for Civil Protection Purposes) and during an interval of 6 hour in which the 24 hours are divided (00-06 UTC, 06-12 UTC, 12-18 UTC, 18-00 UTC). Two events in a single area during a single time interval were considered as unique.

This definition could seem too much arbitrary, but it has the advantage to conciliate the convective rain definition with the operational forecasts, that are issued over alert areas every 6, 12 or 24 hour intervals.

The results show a high annual variability of the events number, with a non-statistically significant signal of increase. If we consider 30 years of events, the increase is more evident, but the data are not fully comparable, because of the different number of stations from the early 90s and the late 10s of the new century.

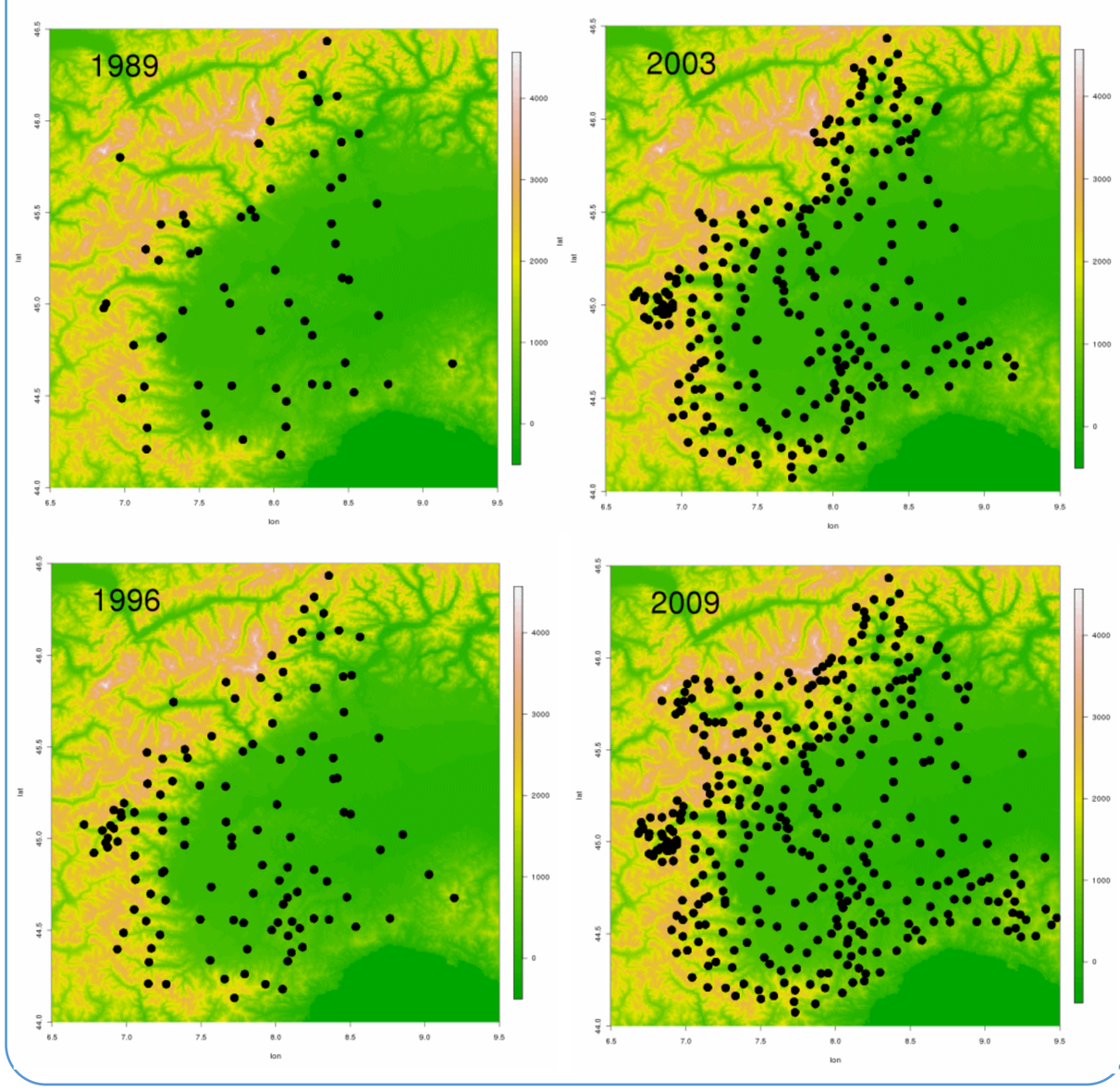
PIEMONTE REGION ALERT AREAS AND RAIN GAUGES NETWORK

Piemonte alert areas are 11 (see figure right). 6 areas are mainly mountainous, with reliefs up to 3000 m and in some areas over 4000 m. The remaining 5 areas are mainly plains, with mean height from 200 to 400 m. At Piemonte Regional Functional Centre at ARPA Piemonte every day are issued thunderstorm early warnings over the 11 geographical areas; that is the reason underlying our definition of "Convective Event". Choosing a short time defined precipitation threshold (20 minutes), allowed us to include in the dataset, in addition to summer months, also spring and autumn months, reducing the risk of mistakenly accounted non convective precipitation events.

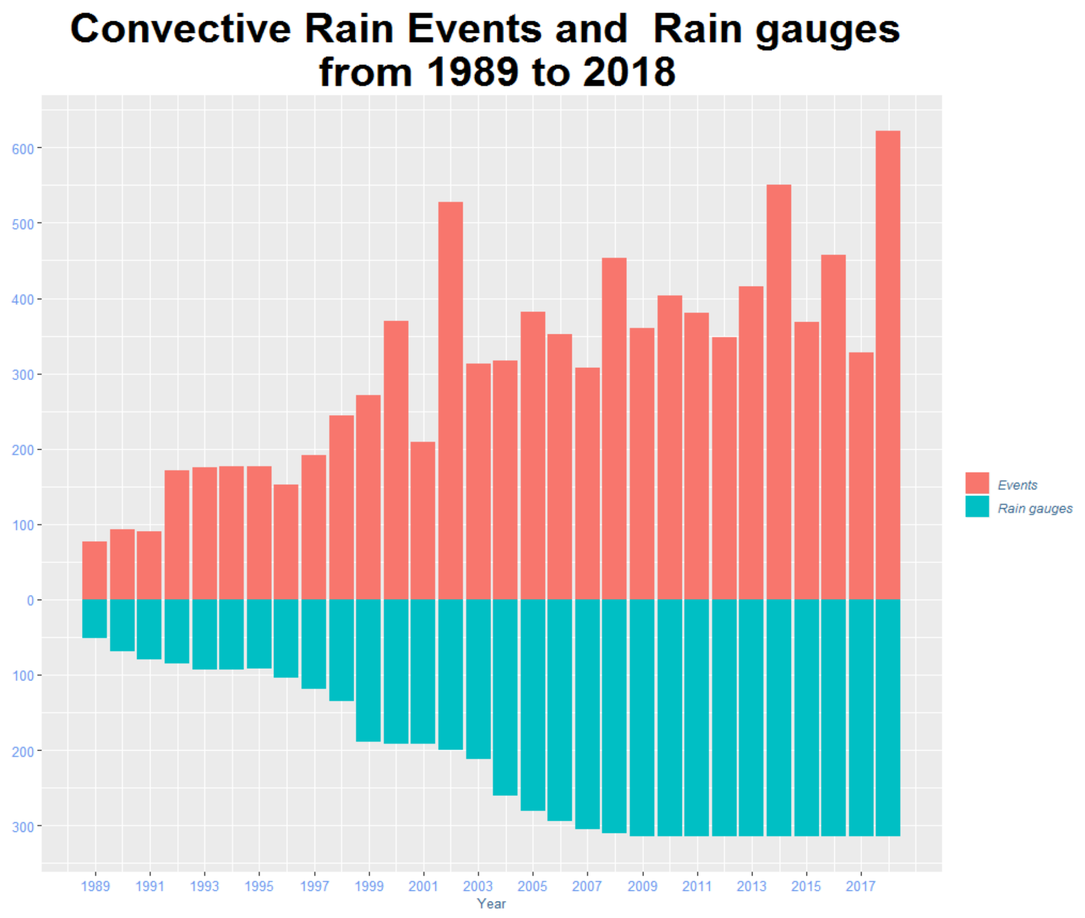


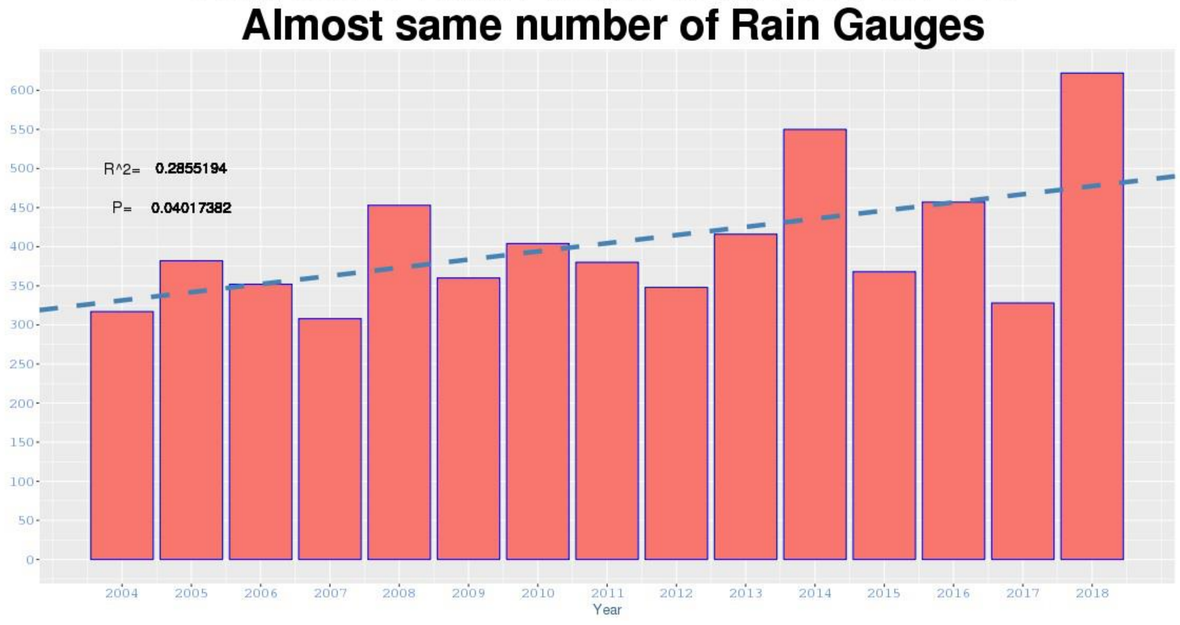
Although there is not an univocal definition of convective rainfall threshold in literature, the link between lightning and heavy rainfall has been extensively analysed (Sheridan *et al*., *1996*, Petersen and Rutledge, *1998*, Soula and Chaouzy, *2001*). In Canada, for example, rainfall rate greater than 50 mm (2 inches) in 1 hour, or 75 mm (3 inches) in 3 hours is also used to indicate severe thunderstorms (ENV.Canada Ontario Fact Sheets, 2005); in hydrology, some studies correlate the core storm intensity with runoffs, choosing arbitrary thresholds on small time scales like 50 mm in 10 minutes (Syed et. Al, 2003). In radar Meteorology convective cells are often identified with reflectivity of 40-45 dbZ, conventionally associated with a rainfall rate of 30 mm/h (Rinehart et al, 1978). The choice of 10 mm in 20 minutes seemed a good compromise to perform the analysis.

In the images below it is shown the increasing rain gauges network in Piemonte region, from 1989 to 2009. From 2009 to date the weather stations density remained almost the same.



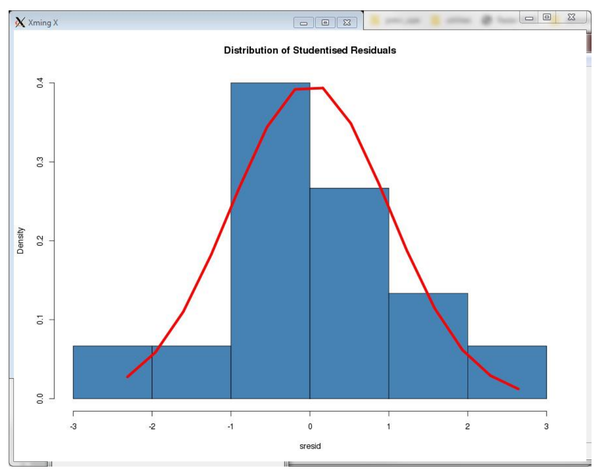
RESULTS





Though at first glance the events number seems to be increasing, account must be taken of the increasing number of the weather stations (rain gauges in particular) over Piemonte Region, from 1989 to 2018.

The weather station number rose gradually from 1989 to 2004; from 2004 to 2009 the number has grown little and from 2009 to present the number has been almost the same. So, the increasing number of Convective Events should be considered carefully from 1898 to 2004, while later it's possible to look for a trend.



The trend from 2004 to date appear to show a slight increase, but the linear regression model shows a coefficient of determination too low (0.29), with a P-Value around 0.04 that suggests that the linear model could not be rejected out of hand. The distribution of the Studentised Residual is reported on the right diagram.

The limits of the analysis are as follows:

1)Not enough years with the same number of rain gauges (around 15 years)

2) Arbitrary definition of Convective Rain Events (Lightning data could be added in the future)

3)Some convective Events are not catched if the center of the precipitation pattern is far away from a weather station

CONCLUSIONS

Even with many limitations, the analysis shows an increasing trend of Convective Rain Events over Piemonte Region, that deserves attention in the future. In the next years, with the regional temperature increasing trend that is already a proven fact, we can expect a change in precipitation regimes, especially in convection cases.

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