Answer to Dr. M. Kamruzzaman comments:

We thank Dr. Kamruzzaman for the constructive comments on the manuscript. We will detail in our response below how we plan to address the comments.

1- It is not clear to me what the main contribution to the work done is, when it is compared with other most-recent scientific report/ publications mentioned. It does not seem that the Mann-Kendall and GPD have been used for the first time in observed variability and trends in extreme rainfall in this work. The authors need to explicitly comment on the main contribution to their work.

It is well known that one of the biggest problems in performing analyses of extreme climate events for most of the globe is a lack of access to high-quality, long-term climate data with the appropriate time resolution for analyzing extreme events.

Few researches have been conducted on trends and variability in our study area (Lake Maggiore Watershed and Piedmont Region) because of the lack of sufficient data.

With the view to improve our understanding of the climate in this area, we analysed the short precipitation data from the recordings of selected meteo stations

Recent progress in automatic systems for rainfall signal recognition from tipping bucket gauge strip charts point out to us the importance of studying the changes in extreme precipitations. So, having for the first time long-term high resolution data (hourly and sub-hourly not daily time scale like most of the report/publications that you mentioned), we started our analysis using conventional statistical and some indices of extreme events (frequency and intensity index), which we think that are appropriate, to test trends in rare weather events. Also we showed that the results obtained are consistent with those provided by Brunetti et al. (2004) for Italy and Burlando (1989) for Florence.

It is anticipated that the research presented will be continued in the future and we will perform a number of valuable analysis and we will compare it to other studies performed in Italy and other parts of the world.

2- The explanation of choice of rainfall indices needs to be expanded. Definition of seasonal indices required at least a parametric test, like using the regression model.

We agree with the reviewer about the necessity to apply a parametric test.

It's important to distinguish between two important cases:
1- A stationary process with a deterministic trend
2- A process with stochastic trend or a unit root

The hypothesis of nonstationarity is tested with two parametric statistical tests adopted from econometrics and aimed at discriminating between stationarity, a deterministic trend and non stationarity in the form of a unit root (including random walk) (Fatichi et al., 2009).

The Phillips-Perron (PP) test (Phillips and Perron, 1988) has been designed to test the null hypothesis of a unit root against a trend stationary alternative. The Kwiatkowski-Phillips-Schmidt-Shin test (KPSS) (Kwiatkowski et al., 1992) test complements unit root tests by testing a null hypothesis that an observable time series is stationary around a deterministic trend.

The Phillips-Perron (PP) test is based on the model (Phillips and Perron, 1988):

$$X_t = \eta + \beta t + \pi X_{t-1} + \Psi_t$$

Where η and β are the parameters of a first-order polynomial regression and the stationary process ψ_t is not assumed to be white noise, with serial correlation in the ψ_t term being handled directly in the test statistic (Fatichi et al., 2009).

The KPSS test is based on the model (Kwiatkowski et al., 1992):

$$X_t = \xi_t + r_t + \varepsilon_t$$

Where

ξ_t is a deterministic trend.

r_t is a random walk

ε_t stationary error

The random walk component is decomposed as : $r_t = r_{t-1} + u_t$

Where

u_t = random variable with mean = 0 and variance σ_u^2

If $\sigma_u^2 = 0$, then the null hypothesis of stationary is true.

If $\sigma_u^2 = 0$ and $\xi = 0$, then the series is stationary about the value r_0.

If $\sigma_u^2 = 0$ and $\xi \neq 0$, then the series is stationary about a trend.

These two tests are complementary and should be jointly employed (Fatichi et al., 2009).

The results of the PP and KPSS tests for the time series analyzed are summarized in table 1.

Table 1: Result of the application of KPSS and PP test

Site	duration	index	PP test[a]	KPSS test[b]	Rejection of deterministic trend
Vercelli	5min	All indices	<0.01	0.1	no
	10min	All indices	<0.01	0.1	no
	15min	All indices	<0.01	0.1	no
	20min	All indices	<0.01	0.1	no
	30min	All indices	<0.01	0.1	no
	1h	All indices	<0.01	0.1	no
	2h	All indices	<0.01	0.1	no
	3h	All indices	<0.01	0.1	no
	6h	All indices	<0.01	0.1	no
	12h	All indices	<0.01	0.1	no
Lombriasco	5min	SUMMER	<0.01	**0.032**	**yes**
		All other indices	<0.01	0.1	no
	10min	SUMMER	<0.01	**0.016**	**yes**
		All other indices	<0.01	0.1	no
	15min	All indices	<0.01	0.1	no
	20min	All indices	<0.01	0.1	no
	30min	All indices	<0.01	0.1	no
	1h	All indices	<0.01	0.1	no

	2h	All indices	<0.01	0.1	no
	3h	All indices	<0.01	0.1	no
	6h	All indices	<0.01	0.1	no
	12h	AUTUMN	<0.01	**0.015**	**yes**
		All other indices	<0.01	0.1	no
Pallanza	5min	All indices	<0.01	0.1	no
	10min	All indices	<0.01	0.1	no
	15min	All indices	<0.01	0.1	no
	20min	All indices	<0.01	0.1	no
	30min	All indices	<0.01	0.1	no
	1h	All indices	<0.01	0.1	no
	2h	All indices	<0.01	0.1	no
	3h	All indices	<0.01	0.1	no
	6h	All indices	<0.01	0.1	no
	12h	All indices	<0.01	0.1	no
Bra	5min	All indices	<0.01	0.1	no
	10min	All indices	<0.01	0.1	no
	15min	All indices	<0.01	0.1	no
	20min	All indices	<0.01	0.1	no
	30min	All indices	<0.01	0.1	no
	1h	All indices	<0.01	0.1	no
	2h	All indices	<0.01	0.1	no
	3h	All indices	<0.01	0.1	no
	6h	All indices	<0.01	0.1	no
	12h	WINTER	<0.01	**0.036**	**yes**
		All other indices	<0.01	0.1	no

a H0: random walk
b H0: trend stationarity
in bold: significant level lower than 5%

From the PP test results one can conclude that the unit root (random walk) hypothesis is rejected for all the analyzed time series; This is not surprising since hydro-climatic time series rarely exibit random walk behaviour (Barbosa et al., 2008)

Regarding the KPSS, test the null hypothesis at the 5% significance level cannot be rejected for all time scales and all extreme indices except :

- Max summer events of 5 and 10 min durations for Lombriasco.
- Max autumn events of 12h duration for Lombriasco.
- Max winter events of 12h duration for Bra.

In this exceptional cases KPSS test reject the hypothesis of deterministic trend (table 1). So trends-like feature in this time series should be considered result of stochastic behaviour rather than stochastic trend. This outcome of the stationarity tests (PP and KPSS) proved the possibility of deterministic trend for all the other durations and indices.

3. Abstract need to be rephrase according to their findings

The following statement will be added to abstract
"Both parametric stationarity tests, Phillips-Perron (PP) and Kwiatkowski, Phillips, Schmidt and Shin (KPSS), showed that, mostly, we cannot reject the trend stationarity hypothesis."

References

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