

Reply to General Remarks:

Thank you for your discussion and for all the suggestions made and designed to improve our scientific work, but we believe that the objectives and especially the complexity of the manuscript have not been fully understood.

It should be noted - first of all - that this isn't a paper on the Genoa's climatology, already studied by several authors until 2001. The goal of the article is to evidence at the scientific community the reality of the floods in Genoa: we want to underline the disastrous effects on the ground, as shown in the title of the manuscript: **"Geo-hydrological hazard and urban development in the Mediterranean area: an example from Genoa City (Italy)"**

The paper has been prepared on the basis of research that since 2011 the group of authors is conducting about geo-hydrological risks in the North-West of Italy. Our interest has had a quick boost after the umpteenth flooding of Genoa: those of 9 October 2014 (famous as "Shame flood") and the subsequent November 15, 2014.

The distribution of the floodings for period of fifty years shown in Figure 12 we believe it is more meaningful to define Genoa an international case for geo-hydrological risk. The tables 2, 4 and 5 show all Genoan floods from the nineteenth century and in our opinion speech for themselves.

We have therefore analyzed briefly the geo-hydrological hazards caused by heavy rains and the vulnerability of the Genoa's area, as a first contribution to knowledge: from this one we are starting to write more and more specific manuscript about geo-hydrological risk factors.

In fact we are studying both climatological aspects of the Genoa metropolitan area (there are several gauges that measure rainfall and air temperature since the beginning of the last century), in collaboration with experts of the specific sector and the aspects of land vulnerability and urban sprawl. In this case we are focusing on some specific "key-basins", as the Bisagno Stream and Chiaravagna Creek, always in the metropolitan area of Genoa, with attention to the study of changes in land use and anthropogenic change over the last 200 years, thanks to the use of old maps of the entire catchment.

The paper submitted is therefore the product of a synthesis of our great effort to illustrate on the one hand the "rain history" that characterizes flood events of Genoa, on the other hand the increased vulnerability of the territory.

If floods are historically determined by the depression of the Gulf of Genoa, known as the "Genoa Low", the last events of the Third Millennium highlight rains much more concentrated in time and space; this aspect was discussed in section 4, where we compared and discussed the six severe flood events of the past 45 years.

The series thermo-pluviometric of Genoa University was taken like example because it allows observations of nearly 200 years; the average annual temperature of the air shows a progressive increase, while rainy days show a gradual decrease.

There is no evidence whether the recent increase in flooding is linked mainly to changes in the rainfall regime or urban sprawl in areas clearly exposed to risk and human-induced changes in the territory.

For this reason we first carried out a multi-temporal maps comparison that allowed us to extrapolate qualitative data (urbanization and changes in land use) and quantitative (section width of the riverbed at key points).

In the discussion and in the conclusions we have duly put in evidence that the factor on which it will be necessary to focus for a valid risk reduction is mainly to land use management.

Finally, we regret not having included our research within the project "Flood change" in cities, one of the goals of the new IAHS decade "Panta Rhei", but in spite internet... we did not know this initiative. We await some instructions from the Associate Editor.

Issues to be addressed

Massimiliano Zappa	Reply
P 2452: I guess the authors forgot to summarize the findings in the abstract. So far the abstracts reads such as a conference abstract where the authors submit in the hope to have something to show some months later at the conference. This is maybe acceptable as a conference contribution, but should be at least adapted in case of manuscripts considered for publication.	Ok, we can improve specifying the objectives of the work and the results obtained, although P2452 illustrates the case of Genoa as an emblematic case for the geo-hydrological risk, both for the critical rains both for uncontrolled urbanization. In the four final lines are lastly summaries the topics dealing in the paper. In detail: the meteorological features of the Genoan floods, the changes in the rate of daily rainfall, the most significant changes of territory above all on the hydrographic network.
P 2453-2454: The Introduction do not contain any single reference to previous work on such topics. There are several studies focusing on analysis of flood events both in hydrology (e.g. Blöschl et al., 2013) and meteorology (e.g. Gram et al., 2013). Some indications are given in Section 3. Too late! Thus I urge the authors to combine section 3 with the Introduction, an so come closer to the form of a scientific manuscript. Please also expand the review of past floods to areas other than your region.	From the first lines of the introduction, we focused on the case of Genoa as an international example of geo-hydrological risk: although the city is infamous in Europe for this reason (Genoa is one of a kind), however there are very few studies available in the literature. To avoid distracting the reader from the main subject of the paper we did not cited bibliographic references of case studies that do not include the city of Genoa, a city that shows characteristics unique of both climatic weather both morphological and geographical.
P 2457: Figure 3 is presented with a very small description on the adopted methodology. Which alternative methods could have been considered? How about homogeneization of the data used (e.g. Begert et al., 2005)?	Figure 3 has been described at methodological level in P2547 lines 17-21, and lines 22-29 in P2547 and P2458 line 1-7. We used the index SAI applying it to almost 200 years of recorded total annual rainfall, average air temperature and number of rainy days per year, since the index provides an immediate understanding of deviation from the mean value. In any case we can still enhance the explanation and discussion of the data, underlining once again, that the fundamental aspect of the paper is not the climatology of Genoa, but the effects to the ground.
2457 – L21: “The annual average temperature shows a clear growth according to recent climate variations”. Please add references!	Okay, we'll insert the appropriate references, although it is now recognized by the scientific community the increase in the average temperature of the air.
P 2459-2462: I see no science in this section 4. This is a valuable communication for local authorities	We strongly reject this brusque claim. The fourth section describes the main events floods in Genoa since 1970. They are ten events, of which we have selected the six most serious, both in terms of rainfall intensity and ground effects (Tab. 4). We have briefly described, highlighting common features and differences. All this on pages 2459 and 2460. From page 2461 line 13 we then brought out the greatest concentration of space-time rainfall, both of 6 events selected are of the highest rainfall recorded in the raingauge of Gavette-Pontecarrega located in middle Bisagno Valley to 1, 3, 6, 12 and 24 hours. The everything summarized in figure 4. In the figure 5 we have also inserted the hourly

	rainfall and water level of creek some flood events, in order to enhance immediate understanding of the greater concentration of rain for the events of the Third Millennium. For this reason, we invite you to read more carefully the section 4 before to judge with too superficiality an important paragraph for the scientific contents.
P2462 – L5: I don't see any trends in Figure 5. Do you mean "time series" or "characteristics". I understand, that the word trend could be used in this sense, but due to its more specific meaning in statistics (e.g. your Figure 3), I think is more appropriate to use another term here.	Ok. The use of the term "trend" has created confusion. Thanks.
Abstract: Include the declaration of the country ("Italy") somewhere	Ok, right.
P 2459, L 5 : Concerning table 4 you could discuss your methodology of documenting events with the one presented in Hilker et al. (2009).	We can read the contribution reported and if necessary to evaluate the need to discuss the methodology adopted for the preparation of this table ..
References:	Thanks for references. The literature about this topic is very wide: a pity that little or nothing exists about Genoa City.