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Discussions

Interactive comment on "Quantitative historical hydrology in Europe" *by* G. Benito et al.

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1. General comments:

The paper submitted by Benito et al. gives an excellent overview about quantitative historical hydrology in Europe. This research field is located at the interface of historical climatology and hydrology (e.g. Pfister, 1999; Brázdil et al., 2005; Glaser, 2001). The paper describes the methodological progress in the focused field under the influence of hydraulics and statistics. The different approaches are presented and their scoop, limitation and range of uncertainties are discussed. The paper is well written and provide an accurate, textbook-like insight into the development and stat-of-the-art of quantitative historical hydrology. I recommend the publication of the paper in the HESS Journal.

Please, find the following suggestions and comments to improve some aspects (e.g. role of mountain headwater catchments):

2. Specific comments:

a) P. 4435, L. 9-15:

The overview paper presents in chapter 5.2 recent trends of multi-proxy analysis (P.4435, L. 9-15). In this context I recommend to include, besides the study on lake sediments, also the development in the field of millennia paleoflood reconstruction from floodplain sediments (e.g. Swiss Alps: Schulte et al. 2008 and 2015, this HESS issue; River Severn in mid-Wales: Jones et al., 2012, Geomorphology 179, 89-105; Tablas de Daimiel, Spain: Santisteban 2015 personal communication, Domínguez-Castro et al., 2008, GLOPLACHA 63, 230-242). These studies analyze geochemical proxies from continuous alluvial records and investigate local documentary flood data to calibrate the paleohydrological records. Despite of the fact that proxies do not reach the annual resolution provided by varved lake sediments, the advantage of the floodplain sediment approach is that catchments size is normally considerably lager than the lakes under research (such as the work of Wilhelm et al. 2012, cited by the authors). Therefore, in the signal of floodplain deposits of mid-size catchments the noise caused by local phenomena (e.g. local thunderstorms) is lower.

With regard to the reconstruction of flood frequencies from lake records (P.4435, L.11) the authors may cite the paper of Wirth et al. (2013; QSR 80, 112-128) which envelopes a larger number of alpine lakes in the Swiss and Italian Alps and trace correlations with the historical flood damage data of Schmocker-Fackel and Naef (2010). In addition, one of the first papers that deals with debris flow and flood calendar in Europe were published by Arnaud et al. (2005; The Holocene 16, 420-428) and Irmler et al. (2006; Geomorpholgy 77, 69-78).

b) P.4434 L.1:

“The largest difference in discharge between historical and gauged flood is mainly characteristic for small catchments and in Mediterranean rivers (e.g. Llobregat, Ter, Ticino, Tiber and Isère rivers).”

Also in many mountain catchments the historical floods are considerable larger than the instrumental data. There are several reasons (Schulte et al., 2015; Peña et al. 2015, HESS this issue):

(i) Recent flood gaps (e.g. from the 1930s to 1977 in Switzerland due to atmospheric dynamics)

(ii) Possible inaccuracy of the instrumental data caused by the overtopping or rupture of river dam upstream of the gauging station. Thus, part of the peak discharge will not be recorded by the instrumental data.

(iii) Influence of dams and reservoirs on peak discharges since the 1930's.

(iv) Magnitude of flood peak discharge due to characteristics of the mountain catchment topography.

(v) Discharge contribution from snow and glacier melt during cooler climate periods (e.g. Little Ice Age). The mechanisms and seasonality of these floods in alpine environments (e.g. Aare and Lütschine rivers; Schulte et al., 2015) (ref. also to P. 4437, L.25) are different from floods caused for example by ice jam and snowmelt in lowlands as occurred in the large central European river systems.

"Mountain basins" could be included in the text as following (or similar):

“The largest difference in discharge between historical and gauged flood is mainly characteristic for small catchments, in mountain basins and in Mediterranean rivers (e.g. Llobregat, Ter, Ticino, Tiber and Isère rivers).”

c) P. 4434, L. 1:

As the paper is concerning the quantification of European floods I recommend the

authors to write a short paragraph (or some lines) about the characteristics of European mountain catchments and progress in related research activities. The headwater catchments of large European river systems such as the Danube, Rhine, Rhone, etc. are located in the Alps and provide in some cases nearly the half of the mean and maximum discharges (e.g. Rhine data at Basel and Rees). Therefore, some large rivers are influenced by the climatic and environmental dynamic of high mountain regions. This influence is shown at Basel regarding the problem of recent trends of winter discharges as outlined by the authors (P. 4437, L.25). However, I am aware about the fact that this extensive discussion would enlarge the paper in a inappropriate way.

Some more references beside the mentioned references about floodplain and lake records regarding the subject of mountain catchments:

Peña, J.C., Schulte, L., Badoux, A., Barriendos, M., and Barrera-Escoda, A.: Influence of solar forcing, climate variability and atmospheric circulation patterns on summer floods in Switzerland, Hydrol. Earth Syst. Sci. Discuss., 11, 13843–13890, 2014.

or: Peña, J. C. and Schulte, L.: Effects of solar activities and climate variability on large floods in Switzerland, Bol. Asoc. Geóg. Españoles, 65, 469-475, 2014.

Pfister, C., and Hächler, S.: Überschwemmungskatastrophen im Schweizer Alpenraum seit dem Spätmittelalter. Würzburger Geographische Arbeiten, 80, 127-148, 1991.

Röthlisberger, G.: Chronik der Unwetterschäden in der Schweiz, WSL Bericht 330, Eidgenössische Forschungsanstalt für Wald, Schnee und Landschaft, Birmensdorf, 1991.

Schmocker-Fackel, P. and Naef, F.: Changes in flood frequencies in Switzerland since 1500, Hydrol. Earth Syst. Sci., 14, 1581-1594, 2010.

Stucki, P., Rickli, R., Brönnimann, S., Martius, O., Wanner, H., Grebner, D., and Luterbacher, J.: Weather patterns and hydro-climatological precursors of extreme floods in Switzerland since 1868. Meteorologische Zeitschrift, 21(6), 531-550, 2012.

Weingartner, R., Barben, M., and Spreafico M.: Floods in mountain areas – an overview based on examples from Switzerland, Journal of Hydrology, 282, 10–24, 2003.

d) P. 4467, Figure 8; PP. 4436-4438:

Did you identified periods of enhanced flooding when comparing the bi-decadal flood frequencies of the 8 European rivers? If not, do other effects besides the atmospheric circulation (moisture from the Atlantic or Mediterranean), such as snow melt, ice jam, land-use, river regulation, increased vulnerability, type of flood according to the different meteorological phenomena, geographic location regarding the path of front systems and cyclones, influence of large lakes on delay and attenuation of flood peak, etc. alter significantly the flood pattern of each river basins in such a way that flood pulses and periods are not synchronous or are masked? I guess that you tried to use other time windows and filtering of the flood series. Looking at the data presented in figure 8 there may exist some (tenuous) coincidence of flood rich periods between the Spanish rivers from 1860 to 1960 and between Vltava, Elbe and Ous from 1500 to 1620 and from 1760 to 1880.

However, I think it would also be an interesting outcome, if correlations do not exist and it would make sense to state this more clearly at the end of section 5.3.

3. Technical comments:

e) P. 4467, Figure 8:

There are some minor problems with the typesetting of the text of figure 8 (text overlaps text or symbols).

Thank you for the opportunity to read the interesting manuscript.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 12, 4413, 2015.