

The unusual floods and flood frequency in 1858–1878 dry period in Central and Western Europe

Libor Elleder¹, Ladislav Kašpárek², Jakub Krejčí¹, Jolana Šírová¹, and Stanislav Racko¹

- ¹Czech Hydrometeorological Institute, Prague, Czechia (libor.elleder@chmi.cz)
- ²T. G. Masaryk Water Research Institute, Czechia (Ladislav_Kasperek@vuv.cz)

Hundred words

Surprisingly, in dry period 1858-1878. we witness an accumulation of important and extreme flood episodes as well. The regional catastrophic floods of 1858, and winter extensive floods of 1862 and 1876, may serve as excellent examples. Furthermore, some countries were affected by extreme (worse event case) floods such as in 1868 in Switzerland, in 1872 in central Bohemia, in 1874 in Catalonia and in 1875 in south France. Can we expect also in the future such intensive extremes?

Abstract

According to the present knowledge, the second half of the 19th century meant the end of the Little Ice Age and gradual warming. This is, however, undoubtedly a fairly simplified statement. Our contribution presents the period of 1858–1878: (1) from the point of view of drought but also (2) regarding frequency of floods. The aggregation for this period of weather-driven risks such as droughts, floods, strong winds and high tides, is worth attention. The length of the drought period of 1858–1878, the absolute value of rainfall deficits and the length of seasonal droughts, as well as their impacts, are a certain warning in terms of our present.

Surprisingly, in such a dry period we witness an accumulation of important and extreme flood episodes as well. The regional catastrophic floods of 1858, and winter extensive floods of 1862 and 1876, may serve as excellent examples. Furthermore, the Elbe catchment recorded floods with return periods of 10–20 years in 1860, 1865 and 1872. For this period, an occurrence of intensive mesoscale flash flood events with extreme hydrological parameters, high number of fatalities and large damages are of the utmost importance (e.g. 1868-Switzerland, 1872-Czechlands, 1874- Catalonia, 1875-South France). Our contribution builds on earlier analysed flood events of 1872, 1875 and drought period presented at EGU earlier. The contribution stresses the analogies and differences with present situation in 2014–2019. We mainly address the situation in Czech lands, Central Europe interpreted in wider European context.

The period of 1858–1878 from the point of view of drought

The period 1858–1878 has a high occurrence of numerous dry periods (especially 1863–1865, 1868) in the territory of today's Czech Republic (Brázdil et al., 2015), or throughout the Central European region (1858, 1874) respectively (Hanel et al., 2018).

We can present the obvious increase of temperature in Prague (Fig. 1), lowering of precipitation (Fig. 2) manifested in PSI indices (Fig.3) (the results in PSEI is similar).

The dry period caused numerous problems and, together with the 1872 flood, led to the gradual development of the rain gauge network and the establishment of the Hydrographic Commission of the Kingdom of Bohemia in 1874.

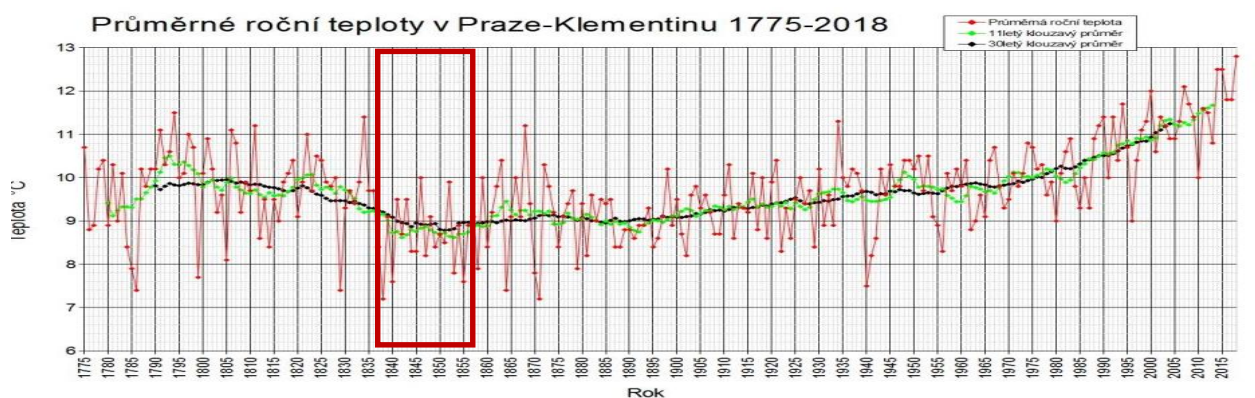


Fig 1. In red the annual averages of temperature in Prague Klementinum observatory, in black 1 year smoothed average, in green 30 years smoothed average

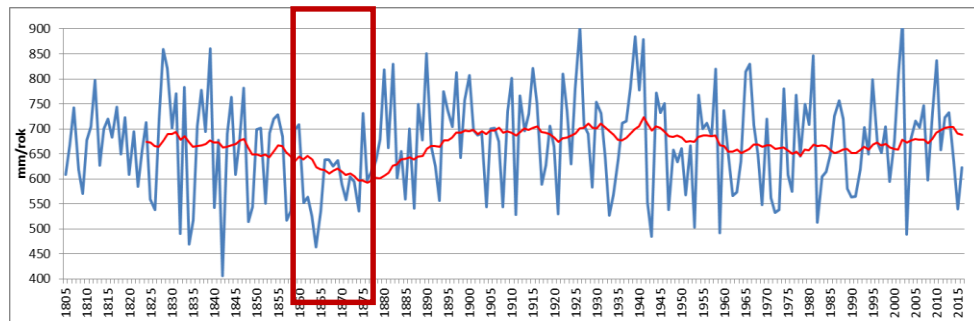


Fig 2. In blue the annual totals of precipitations in Prague Klementinum observatory, in red 30 years smoothed average.

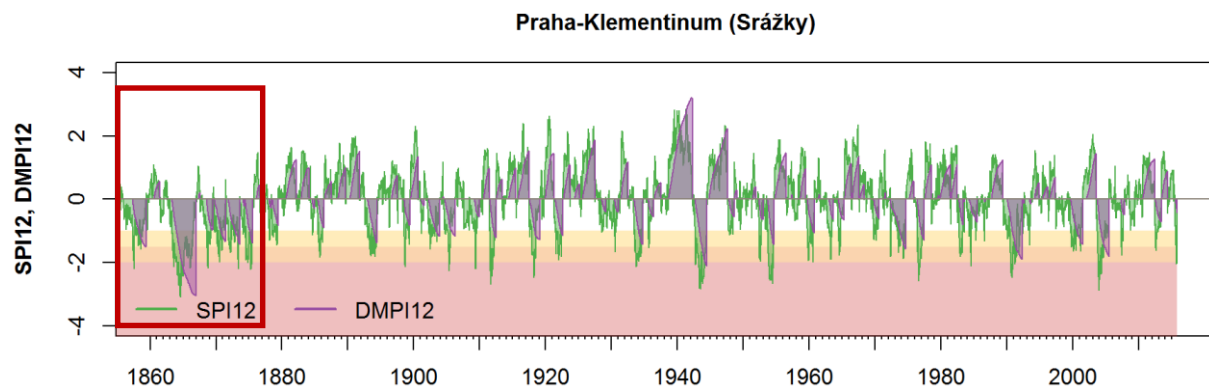


Fig. 3 Assessing of the drought. 12month smoothed precipitations totals by indices SPI12 a DMPI12 in Klementinum observatory from 1860 to 2015 (by Radek Vlnas, prepared for until today unpublished study on drought period 1858-1878)..

The period of 1858–1878 from the point of view of droughts and floods

The 60s and 70s of the 19th century can in many ways be a source of valuable insight in the study of current extremes during the period of climate change. Central Europe experienced a series of drought periods in the 60s and 70s of the 19th century (Brázdil et al., 2013, 2015; Hanel et al., 2018). However, several extreme floods occurred in Europe during these decades including floods in the Southern Alps in 1868 (Stucki et al., 2018; Brönnimann et al., 2018b), Santa Tecla flood in Catalonia in 1874 (Balasch et al., 2010) or Garona flood in 1875 (Lang and Coeur, 2014). Similarly, the flood in 1872 at the Berounka River and its tributaries in Central Bohemia had been out of the current experience and remains not exceeded until today (Elleder, 2020b). In the European context, however, the year 1872 is linked foremost with the October floods at the Po and Loire rivers (Gautier et al., 2004) and the storm and stormy tides at the Baltic Sea on 13 and 14 November, which overcame the worst known similar floods in 1694 and inflicted great damage to coastal cities (Elleder et al. 2020b).

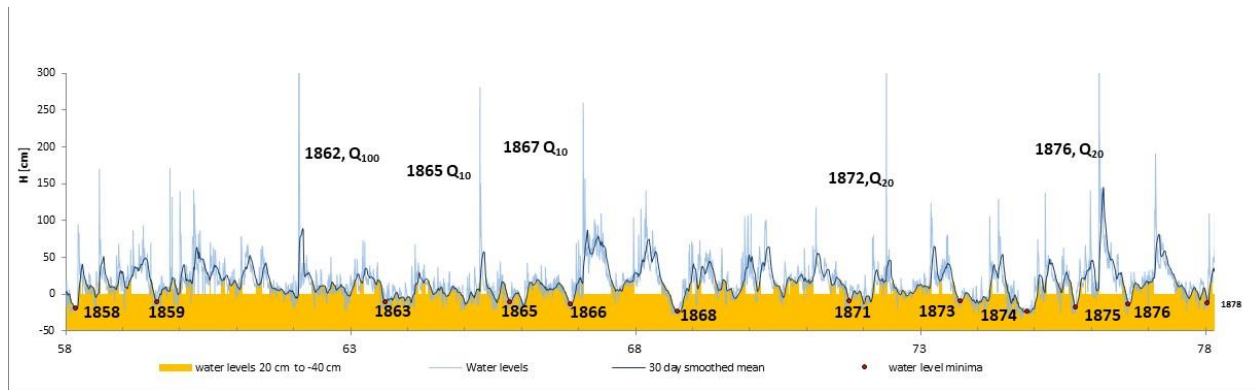


Fig. 4 Indication of flood rich a dry period at the som time. Water levels in Prague from 1858 to 1878. In yellow water stage below 20 cm. The iportant cases are highlighted with years.

Indication of low water level: 12-times (Fig.4)

(1858, 1859, 1863, 1865, 1866, **1868**, 1872, 1873, **1874**, 1875, 1876, 1878)

The mimum water levels (1858, 1863, 1868, 1873, 1874) were signed on some Hunger stones in Elbe River (see Elleder, 2020a).

Indication of Q_{10} floods: 5-times (threshold: return period 10 years)

Q_{100} 1862, Q_{20} : 1872 (Fig. 5), 1876, Q_{10} : 1865, 1867.



Fig. 5 Precipitation and floods from 24 May to 26 May 1872 in Europe



Fig.6 June 1875, Toulouse, France



Fig.7. June 1875, Budapest



Fig.8 August 1875, Hahnenbach, Germany

The EGU2017 presentation Elleder et al (2017) enabled a general view of the situation in summer 1875, offering a day-after-day analysis in a wider spatial context of Europe (figs 7 and 8). It pointed out the possible link between the 1875 flash floods and preceding catastrophic eruption of the Iceland volcano Askja (fig. 9), influencing by tephra the most of Europe. The EGU presentation has focused to analogical situation in 2009, specifying the similarities and differences of both flash flood series. Interestingly, the 1875 has been so far associated only with catastrophic flood in June in Southern France. Nevertheless, simultaneously occurring flood events in Central Europe have been lost more or less.

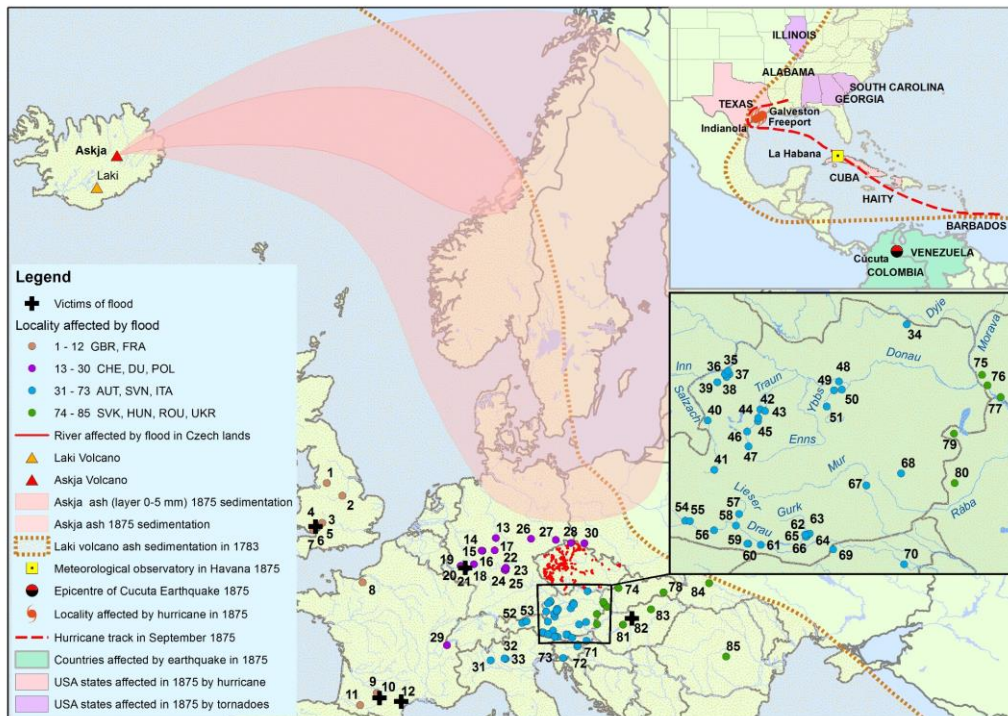


Fig. 9 June, July, August and September 1875: high frequency of flash floods in Central and Western Europe.

Catastrophic floods in Switzerland and catastrophic drought in Bohemia, both in September 1868

Probably the cold front and blocking high pressure over Central Europe caused big floods in Switzerland (Fig.10) and droughts in Elbe catchment (Fig.11).



Fig. 10. Lustenau in Switzerland, floods - worse event case



Fig.11 Prague in Austrian Empire, Czech kingdom, low water stage and drought in September 1868

Discussion and conclusion

Our contribution builds on earlier analyzed flood events of 1872, 1875 and drought period presented at EGU earlier. The meteorological situation, dry condition, water balance, the impact on the forests is analogical with present situation in 2014–2020. The situation regarding large floods and flash floods is strongly different from 1860th a 1870th. In Czech Republic was the last important flood noticed in 2013. Can we expect similar catastrophic events such as 1868, 1872, 1874, 1875 in next years?

References:

Balasch, J.C., Ruiz-Bellet, J.L., Tuset, J., Martín de Oliva, J., 2010. Reconstruction of the 1874 Santa Tecla's rainstorm in Western Catalonia (NE Spain) from flood marks and historical accounts. *Nat. Hazards Earth Syst. Sci.* 10 (2317–2325). doi:10.5194/nhess-10-2317-2010. <https://www.nat-hazards-earth-syst-sci.net/10/2317/2010/nhess-10-2317-2010.html>.

BDHI [online], [cit. 2018–09–01]. Available from WWW <http://bdhi.fr/appli/web/view/inondation2018>

Brázdil, R., Dobrovolný, P., Trnka, M., Kotyza, O., Řezníčková, L., Valášek, H., Zahradníček, P., Štěpánek, P., 2013. Droughts in the Czech Lands, 1090–2012 AD. *Clim. Past* 9, 1985–2002.

Brázdil, R., Trnka, M., et al., 2015. Sucho v českých zemích: Minulost, současnost, budoucnost (Drought in the Czech Lands: past, present, future). Global Change Research Institute of the Czech Academy of Sciences, Brno, p. 400.

Elleder, L., 2015. Historical changes in frequency of extreme floods in Prague. *Hydrol. Earth Syst. Sci.* 19, 4307–4315.

Elleder, L., Šírová, J., Racko, S. 2017. Summer 1875 Flash Floods in Central and Western Europe, EGU 2017 conference, available on <https://ui.adsabs.harvard.edu/abs/2017EGUGA..19.3613E/abstract>

Elleder, L., Kašpárek, L., Šírová, J., Kabelka, T. 2020a. Low Water Stage Marks on Hunger Stones: Verification for the Elbe River in 1616–2015, *Climate of the Past*, in the print.

Elleder, L., Krejčí, J., Racko, S., Daňhelka, J., Šírová, J., Kašpárek, L., 2020b. Reliability check of flash-flood in Central Bohemia on May 25, 1872, *Glopalacha*, vol. 187.

Govi, M., Maraga, F., 1995. Gli eventi catastrofici del Fiume: Poin epoca storica. *Accademia delle Scienze di Torino, Quaderni* 1, 35–48. Haiden, T., Kerschbaum Kahlig, M. P., Nobilis, F., 1992. A refined model of the influence of orography on the mesoscale distribution of extreme precipitation. *Hydrological Sciences Journal* 37(5), 417–427.

Hanel, M., Rakovec, O., Markonis, Y., Máca, P., Samaniego, L., Kyselý, J., Kumar, R., 2018. Revisiting the recent European droughts from a long-term perspective. *Scientific Reports* vol. 8, n: 949911p.