ČESKÝ
HYDROMETEOROLOGICKÝ
ÚSTAV

Hydrological Approach for Flood Reconstruction

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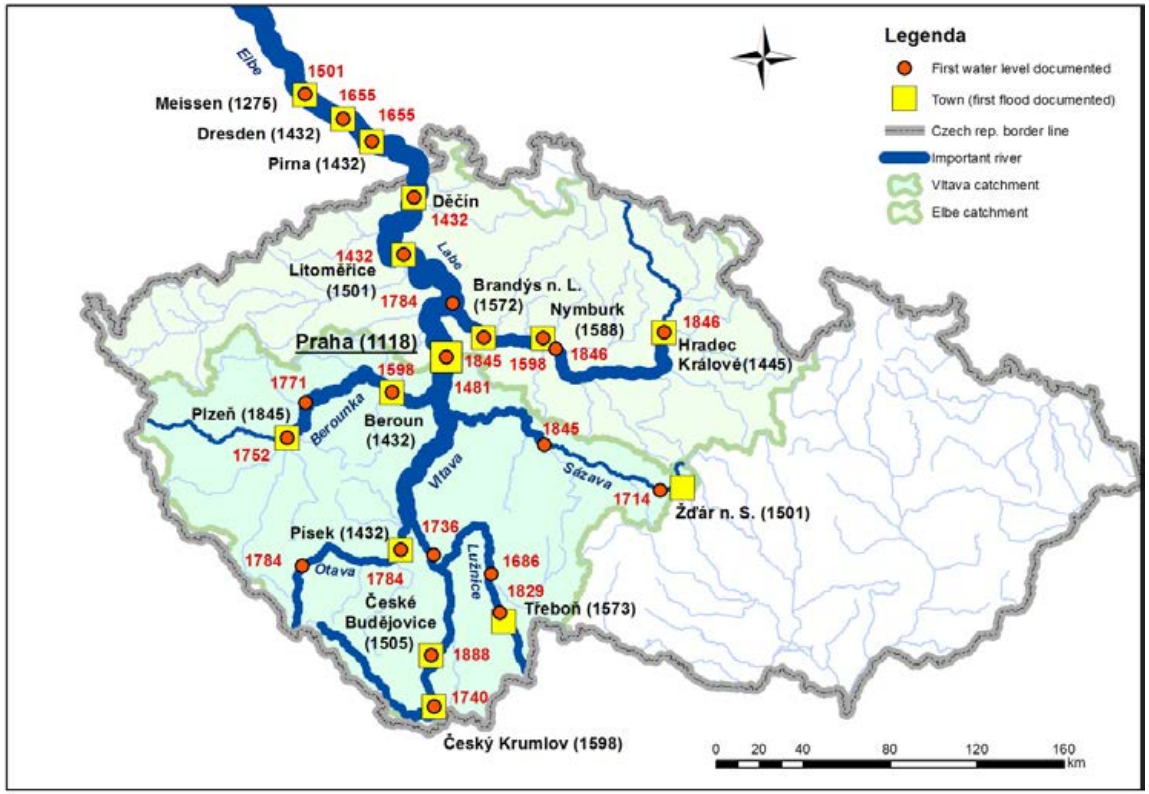
The Vltava River catchment: The major tributaries and sites with records of historic floods and flood marks.

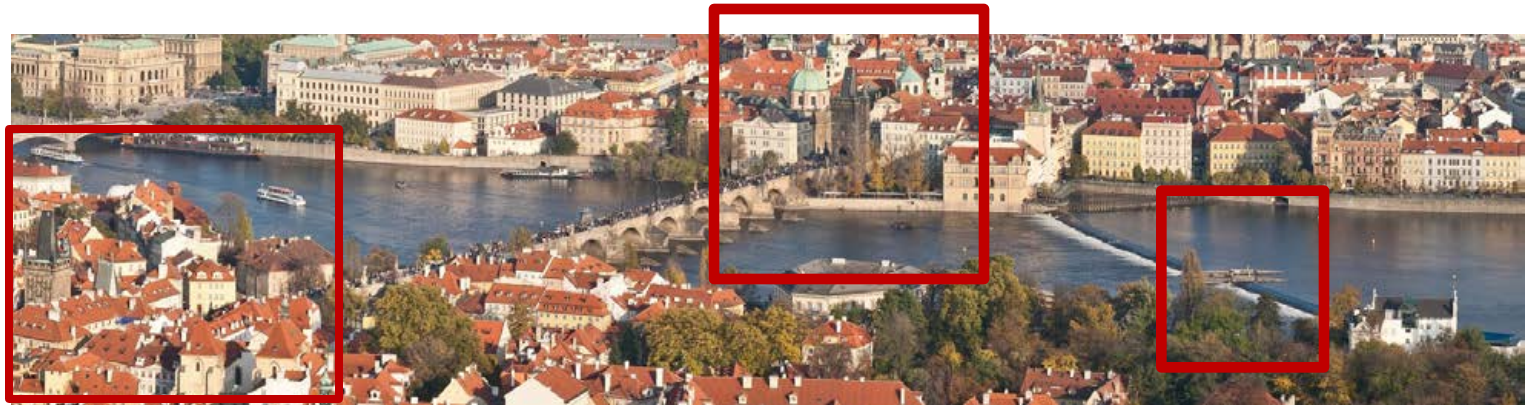
- **Vltava River, Prague**
- **Length** : 430,3 km
- **Qa:** 143 $m^3.s^{-1}$
- Q_{10} = 2200 $m^3.s^{-1}$
- **Q_{100}= 4020 $m^3.s^{-1}$**
- **Area**= 26720 km^2



- **Upper Vlta**va
- Q_{100}= 908 $m^3.s^{-1}$
- **Main tributaries:**
- Otava River Q_{100}= 863 $m^3.s^{-1}$
- Berounka Q_{100}= 1560 $m^3.s^{-1}$
- Lužnice Q_{100}= 577 $m^3.s^{-1}$
- Sázava Q_{100}= 702 $m^3.s^{-1}$

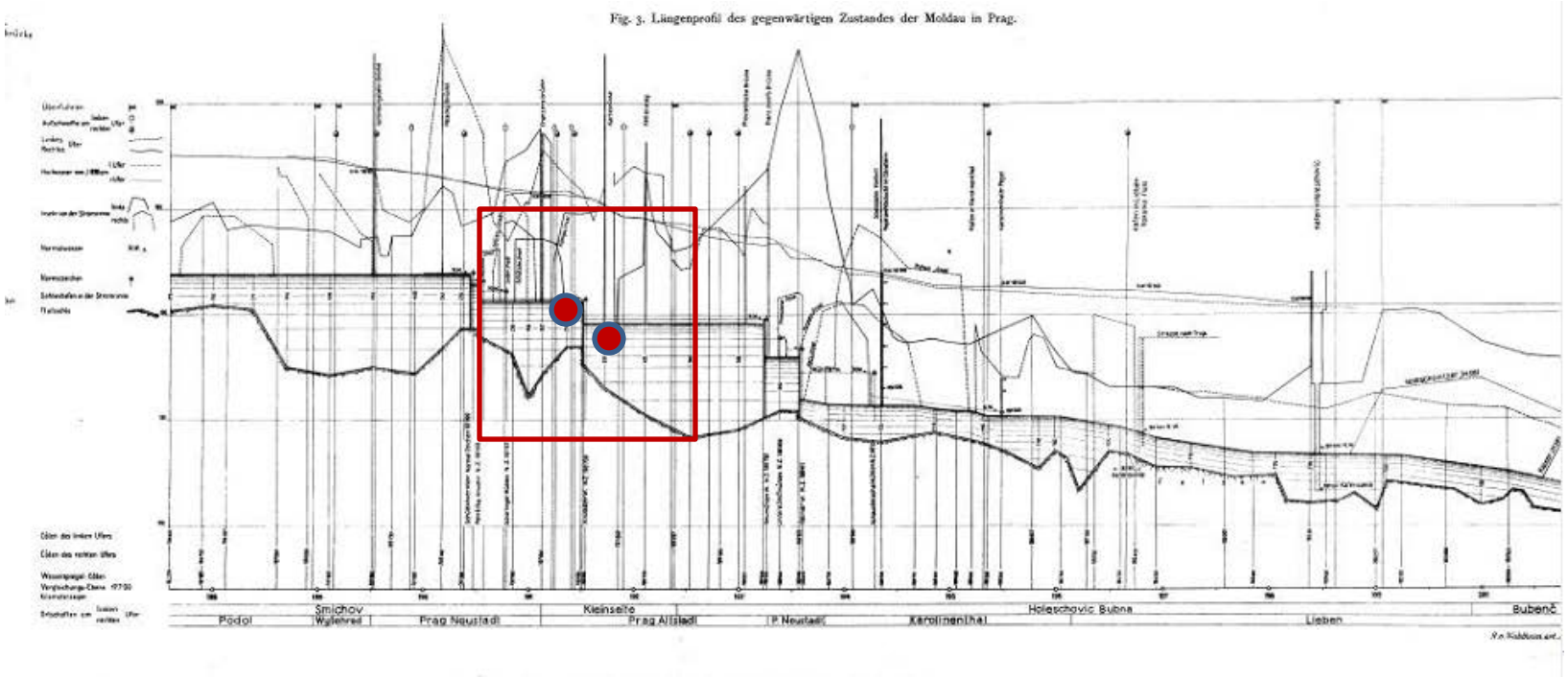
- Labe (Elbe) before confluence with Vltava Q_{100}= 1500 $m^3.s^{-1}$
- Labe (Elbe) after confluence with Vltava Q_{100}= 4150 - 4300 $m^3.s^{-1}$

Are the hydrological conditions in Prague changed as compared to the past?



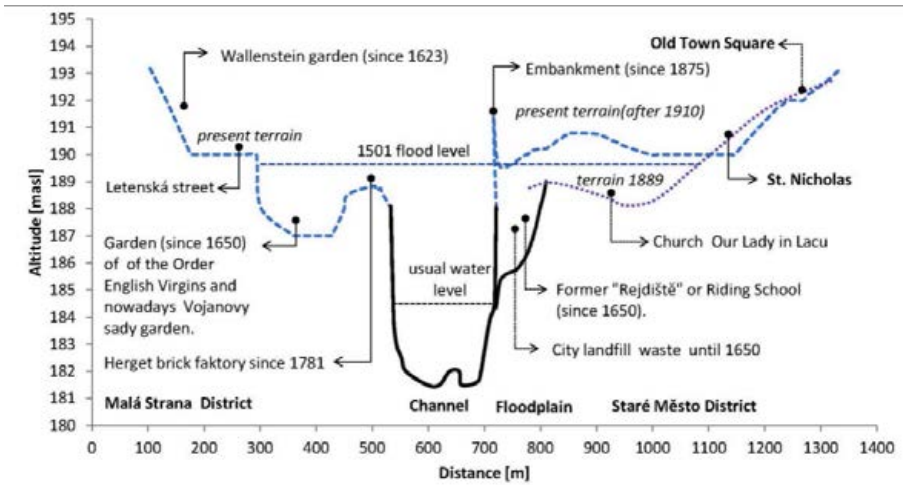
Comparison of the situation in 1635: the engraving by Václav Hollar (1635) and a current view from the Petřin hill.

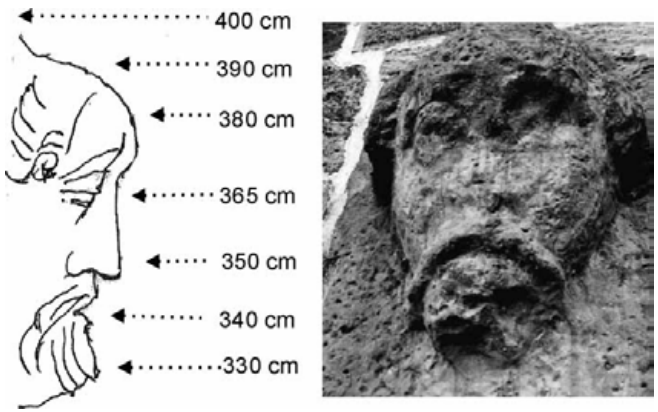
Weirs in historical part of Prague



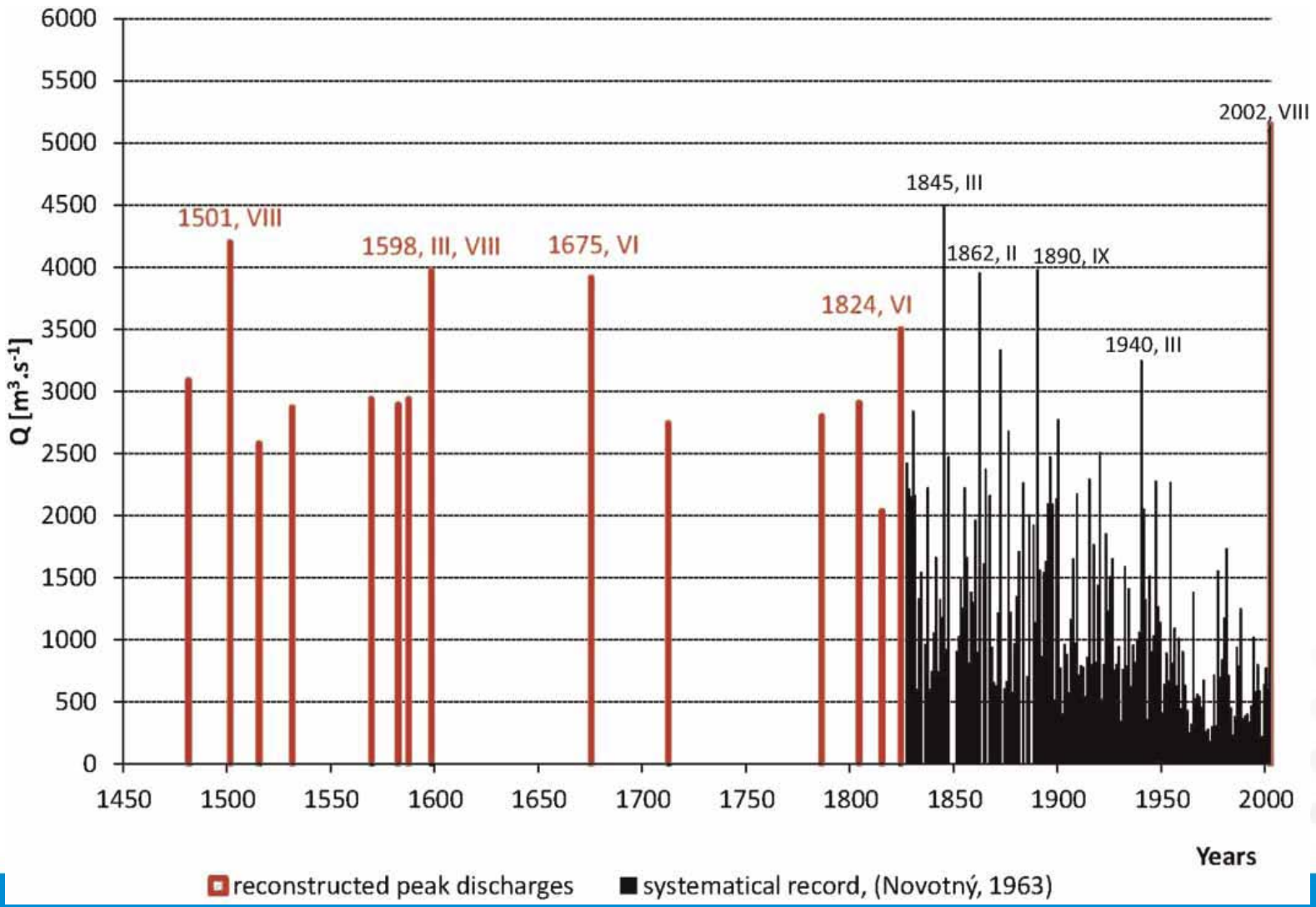
Red points: site of gauge and flood marks
Long section by Wilhelm Plenkner (1897)

Cross-section profiles of the river channel and floodplain

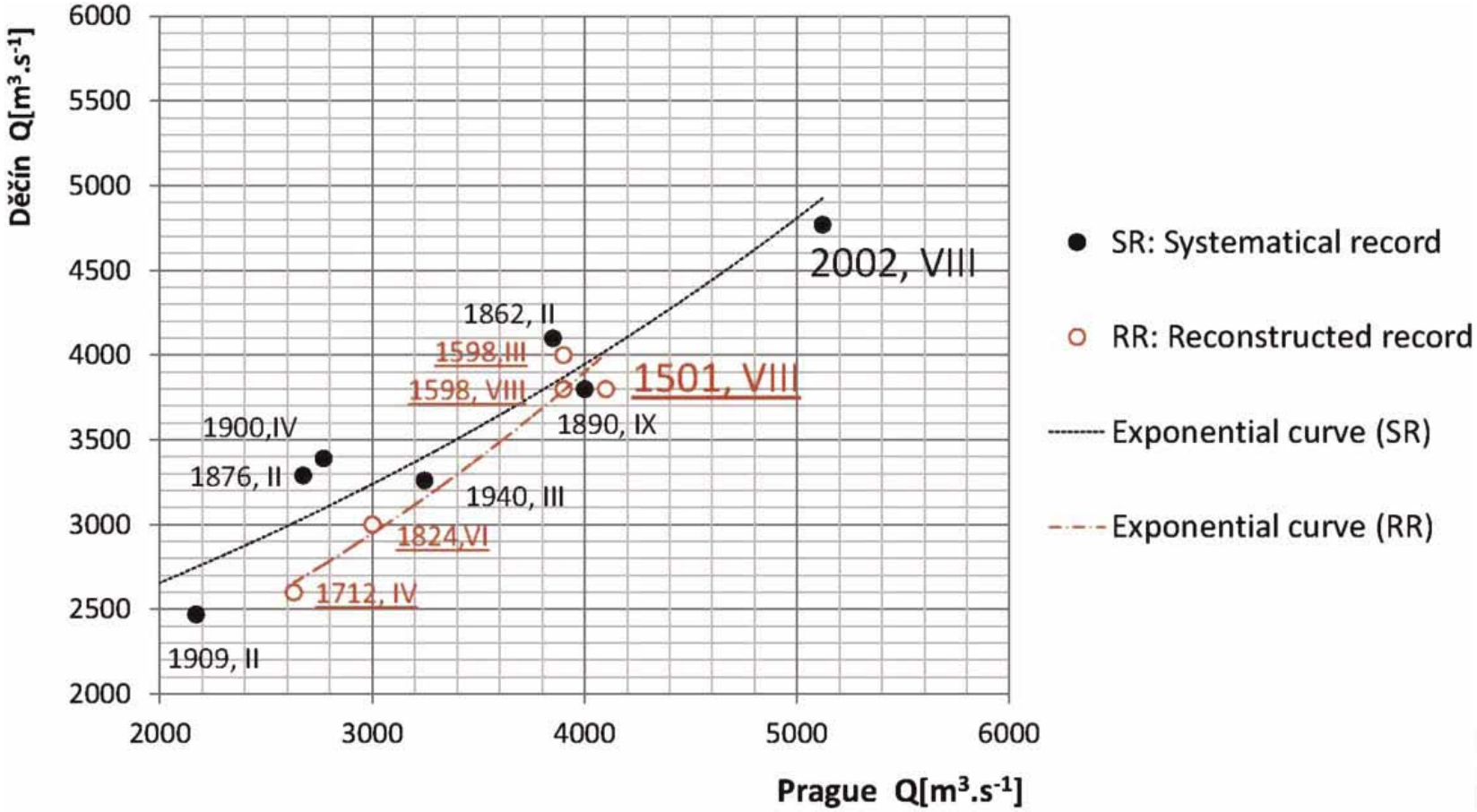




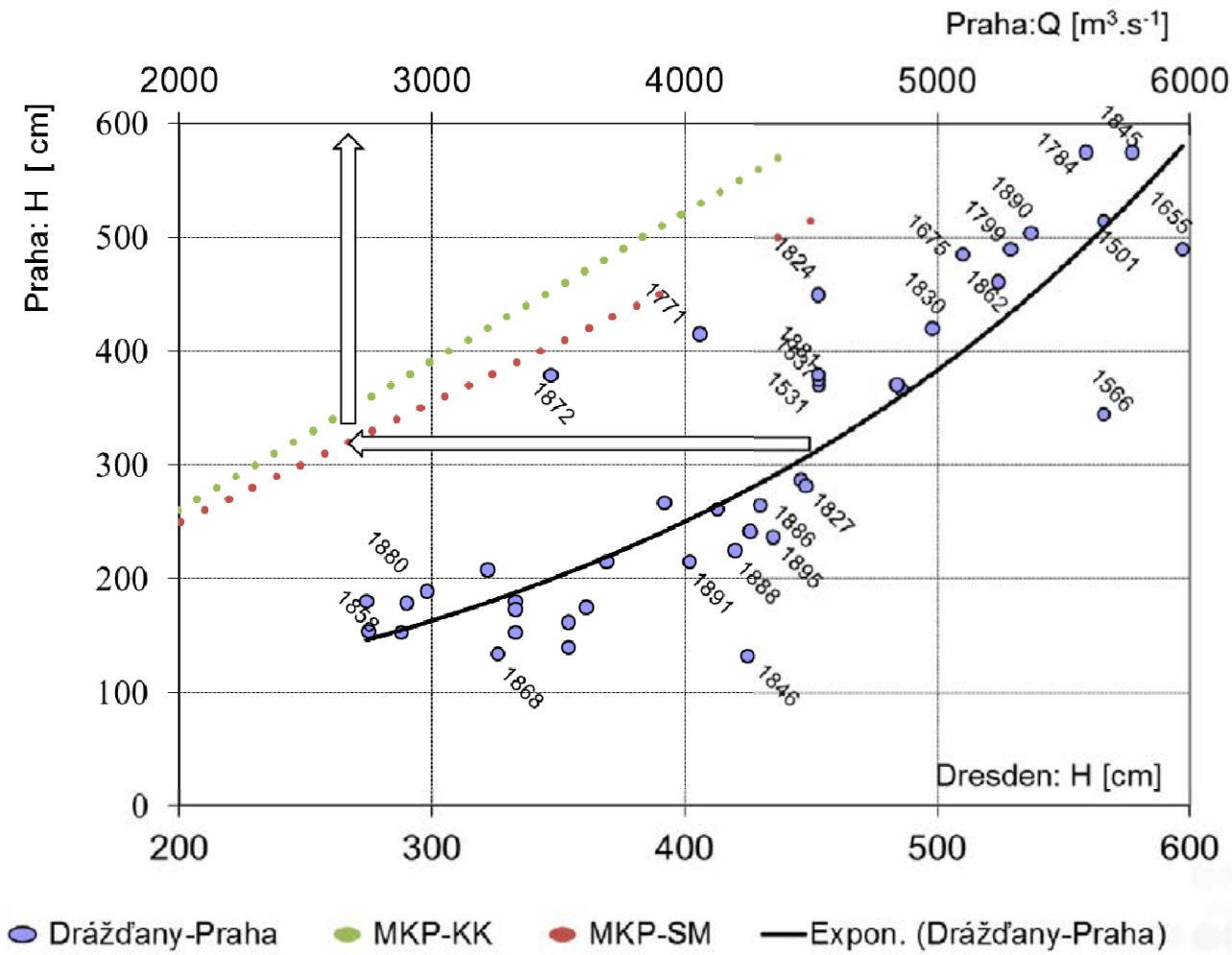
Switch to discharges:
estimation of the peak discharges of historic floods



The relationship between Prague and Děčín



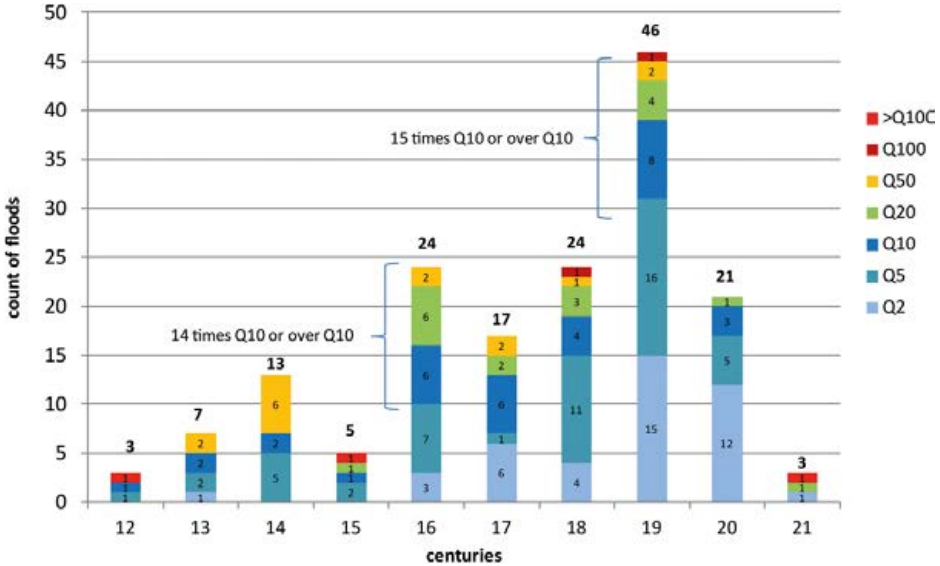
Using more sites (river network) for estimation of flood peaks



Possible pittfals

- Wood barriers (summer floods)
- Dam or levees break
- Ice jamming (winter floods)
- Retention effect, reduction of peak discharge
- Travel time of peak discharges

Historical changes in frequency of extreme floods in Prague



Frequency of floods in Prague over the centuries

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Historical changes in frequency of extreme floods in Prague

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Abstract. This study presents a flood frequency analysis for the Vltava River catchment using a major profile in Prague. The estimates of peak discharges for the pre-instrumental period of 1118–1824 based on documentary sources were carried out using different approaches. 187 flood peak discharges derived for the pre-instrumental period augmented 150 records for the instrumental period of 1825–2013. Flood selection was based on Q_{10} criteria. Six flood-rich periods in total were identified for 1118–2013. Results of this study correspond with similar studies published earlier for some central European catchments, except for the period around 1750. Presented results indicate that the territory of the present Czech Republic might have experienced extreme floods in the past, comparable – with regard to peak discharge (higher than or equal to Q_{10}) and frequency – to the flood events recorded recently.

1 Introduction

Research of historic floods significantly enhances our ability to better understand the behaviour of recent flood events in the context of global environmental change. Numerous studies have focused on this issue in the last 2 decades (e.g., Brázdil et al., 2006b; Glaser et al., 2010). The augmentation of systematic hydrological series by interpreted historic records to provide a better and more accurate estimation of hydrological parameters is an important task. Flood frequency analysis (FFA) appears to be a real challenge, particularly for limited data sets as indicated for example by Mudelsee et al. (2003) and Stedinger and Cohn (1986). In this study, the estimated flood discharges are used for identification of flood-rich periods.

In the Czech Republic, four extreme summer floods were recorded within the last 15 years (1997, 2002, 2010, and 2013). Two of these were classified as 500-year or even 1000-year events (Blöschl et al., 2013; Hladný et al., 2004); two out of the four stroke the Vltava River catchment. Taking into account the entire region of central Europe, further extreme summer floods can be added: in the Alps in 2005, and in Slovakia and Poland in 2010. An interesting question thus emerges as to whether there is an analogy with a similar frequency of important or extreme floods in the past. The aim of this contribution is to answer two scientific questions:

1. Has the territory of the present Czech Republic experienced four summer extreme flood events within a mere 15-year period earlier in history?
2. Did the region of central Europe record extreme large-scale floods during the last 500 years more often when compared to the present? The methodical approach used in this study was inspired by Bayliss and Reed (2001).

Prague is, with respect to floods, a key point for central Europe. It represents a closing profile of the Vltava River, the most important tributary of the Elbe River. As compared to other major Elbe tributaries, such as the Saale, Spree, and the Mulde, with respect to the catchment area, average discharge and Q_{100}, the Vltava River can be regarded as the most significant one. According to the above criteria, the Vltava River is even more significant as compared to the upper part of the Elbe River, where it flows to, 40 km downstream of Prague, at the town of Mělník. Q_{100} values of the Otava and Berounka Rivers, the most important tributaries of the Vltava River, correspond merely to the Q_2–Q_5 level (Table 1). Interestingly, this also applies for the Elbe River prior to the confluence with the Vltava River, which implies that the Elbe River is a tributary of the Vltava River rather than the other way around (Table 1). These facts are absolutely

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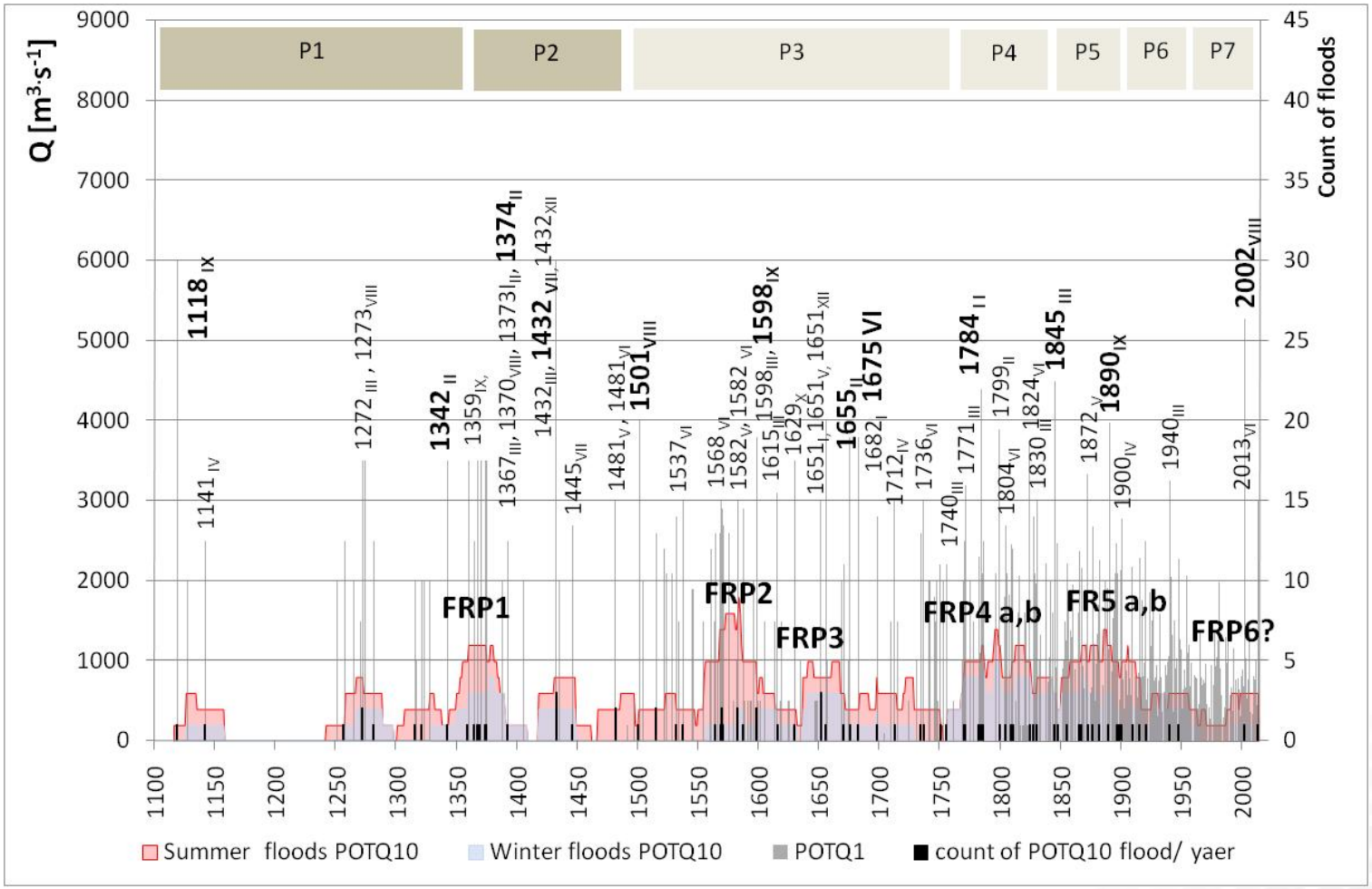
Running 31-year frequencies in summer and winter floods in Prague with identification of flood-rich periods



Large scale floods

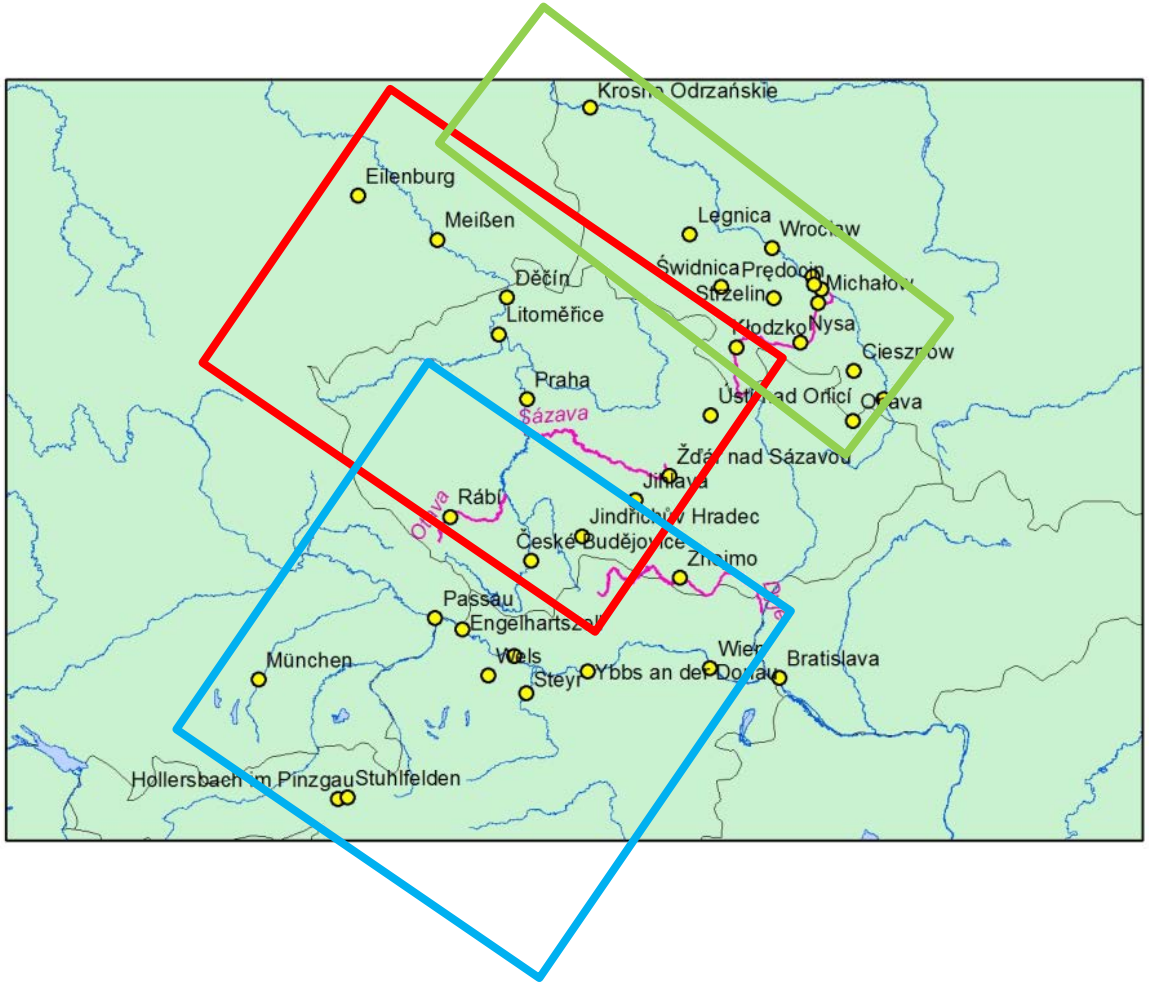
- **CEF, Central European Floods**: $POTQ_{10}$ floods recorded in the Vltava River affected a major part of Central Europe as well, at least two or three major catchments out of five: the Elbe, Danube Oder, Wesser, Warta and Rhine. These floods can be labelled as Central European Floods (CEF, further in the text).

- **WCEF, West-Central European flood:** In cases when other catchments (the Seine, Loire, Maas, etc.) were also affected, the acronym WCEF is used.

Regional context

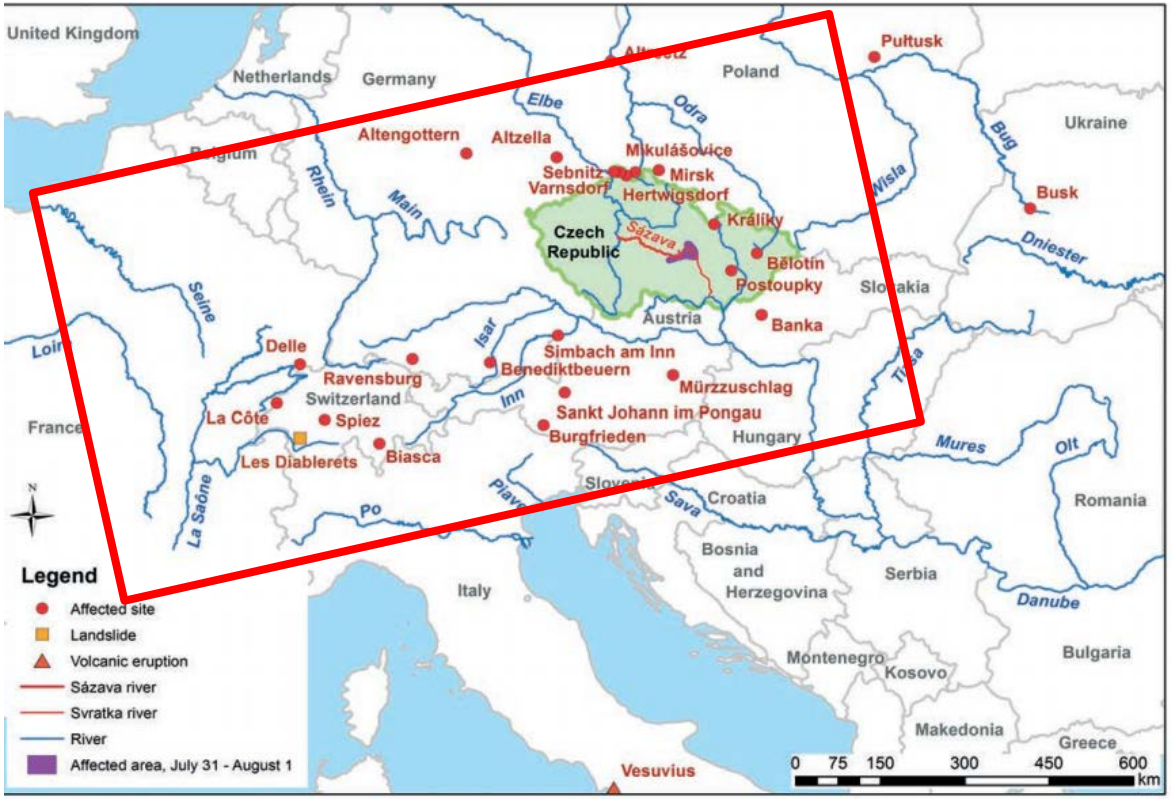
- **FRP1 (1350–1390):** Summer: 1359, 1387 (CEF), Winter: 1374 (CEF)
- **FRP2 (1560–1600):** Summer: 1501, 1569, 1598 (CEF). Winter: 1570, 1566 (CEF)
- **FRP3 (1650–1685):** Winter: 1651, 1655, 1658, 1682 (CEF).
- **FRP4a (1770–1800):** Winter 1771 (CEF), 1784 (WCEF), 1799 (WCEF).
- **FRP4b (1804–1830):** Winter: 1830 (CEF), Summer: 1804(CEF).
- **Period FRP5a (1845–1880):** Winter: 1845, 1862, 1876 (CEF).
- FFS 1872, 1875
- Winter: 1846, 1858 (CEF).
- **FRP5b (1880–1920)** Winter: 1882,1920 (CEF), Summer: 1897, 1899 (CEF)
- **FRP6 (1994-????) Summer: 20002, 2013 (CEF)**

Large scale flood in August 1501

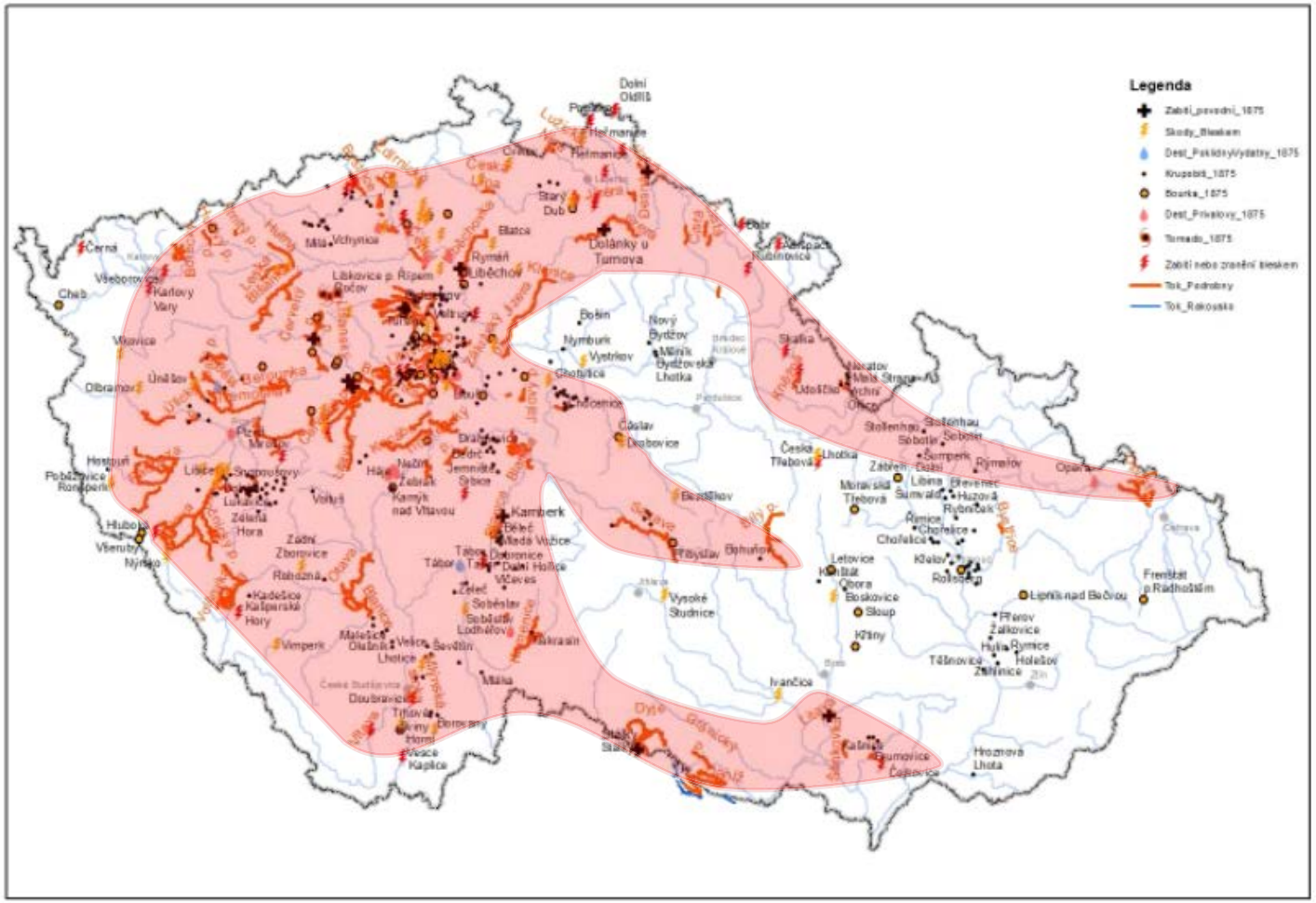


- Bavaria
- Austria
- Bohemia
- Moravia
- Silesia
- Danube
- Elbe
- Oder

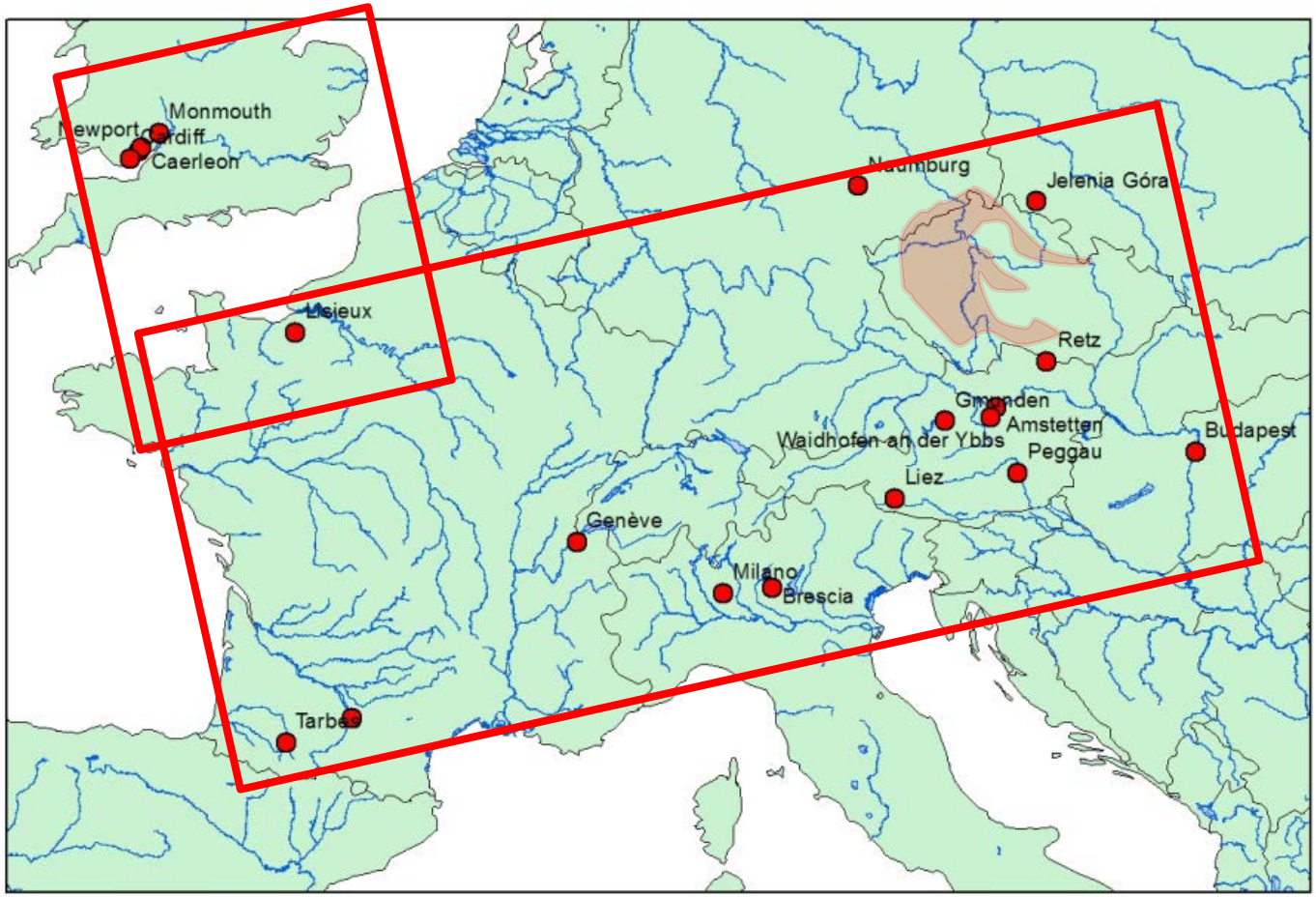
Flash floods and landslides in summer 1714



Flash floods in 1875



Flash floods and important storms in summer 1875



Conclusion

- **What am I suggesting?**

1. ***Selection of important 20–50 WEF, W-CEF or CEF floods for 1500–1900***
2. ***Reconstruction of each event***
3. ***Establishing of the event oriented flood database***

Thank you for your attention