

Chronology of strong winds based on documentary evidence in the Czech Republic from AD 1510

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L. Dolák^{1,2}, R. Brázdil^{1,2}, P. Dobrovolný^{1,2}, L. Řezníčková^{1,2}, K. Chromá², O. Kotyza³,

¹ Masaryk University, Institute of Geography, Brno, Czech Republic

² Global Change Research Institute, Czech Academy of Sciences, Brno, Czech Republic

³ Regional Museum, Litoměřice, Czech Republic

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Introduction

Because of relatively short series of wind-speed measurements in the Czech Lands starting in the first half of the 20th century, documentary evidence represents an important source of information about strong winds in the pre-instrumental period. Based on different documentary records, a database of strong winds in the Czech Lands from AD 1510 was created. The study presents preliminary results from the analysis of 508-year long-term chronology of strong winds, which are discussed with respect to uncertainties associated with documentary evidence.

Data

Although the earliest credible report of strong winds in the Czech Lands is dated already to 30 July 1119 in Prague (Bretholz, Kosmas, 1923), the density of records about strong wind events increases significantly as far as from the early 16th century. Documentary evidence is presented particularly by narrative sources (annals, chronicles, memoirs - Fig. 1), economic and financial sources (taxation and damage records - Fig. 2), official correspondence (letters), weather diaries, historical research into forests (Fig. 3), special prints, early newspapers (Fig. 4), forestry records, scientific papers and communications, and early meteorological observations.

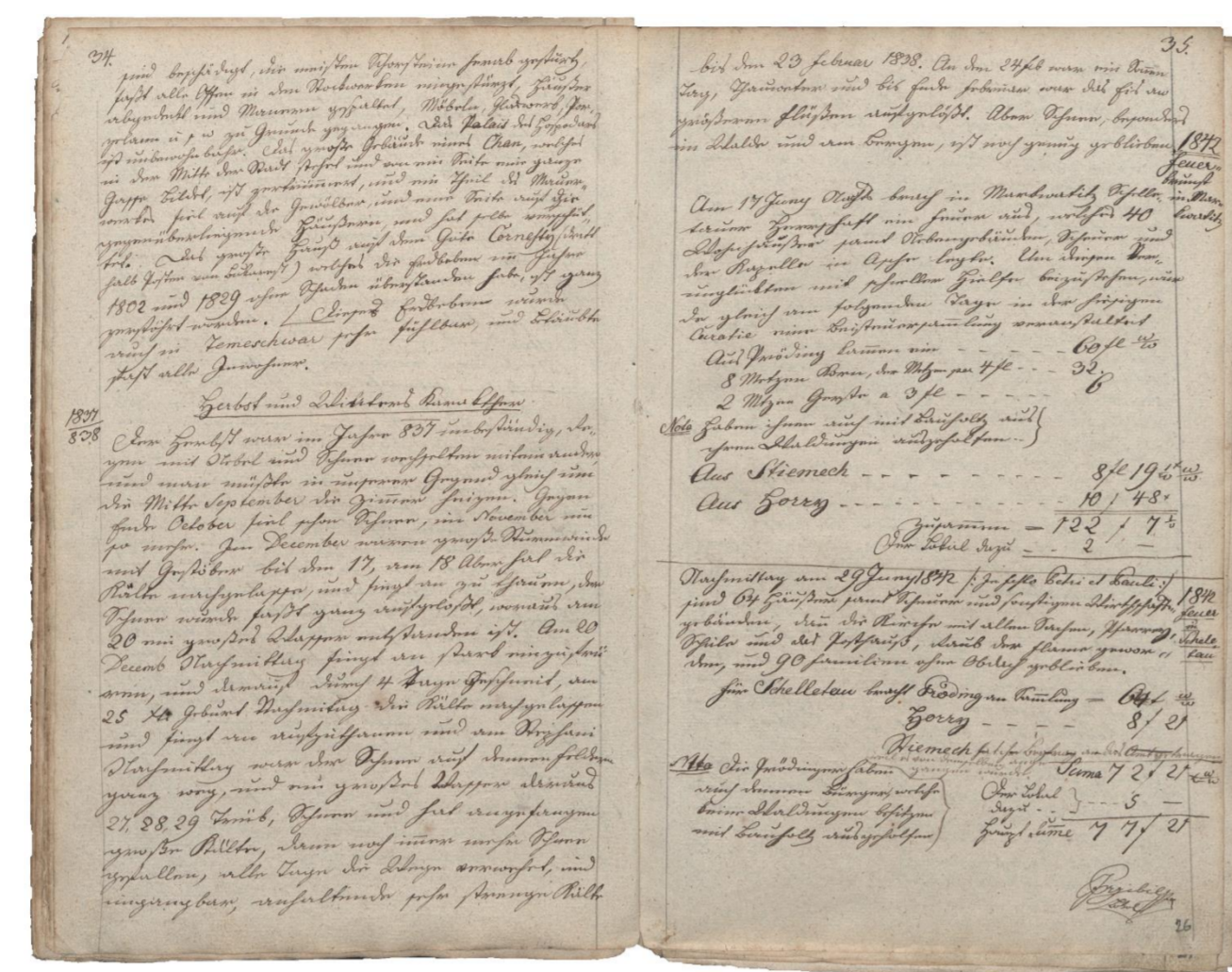


Fig. 1 Weather description in 1837-1838 recorded in Předín memory book (S3)

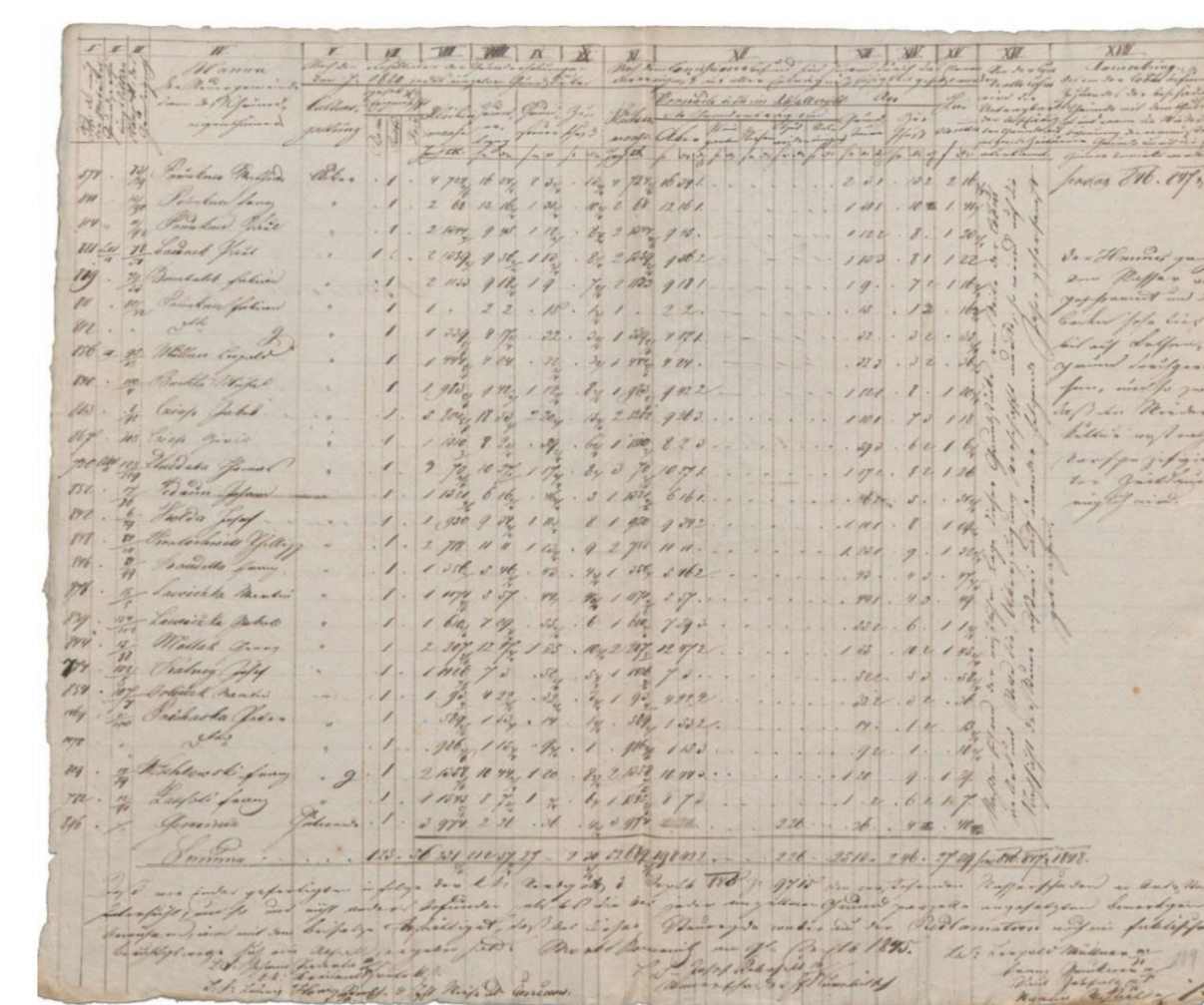


Fig. 2 Taxation record related to damage caused by convective storm on 27 August 1845 in Kamenice (S1)

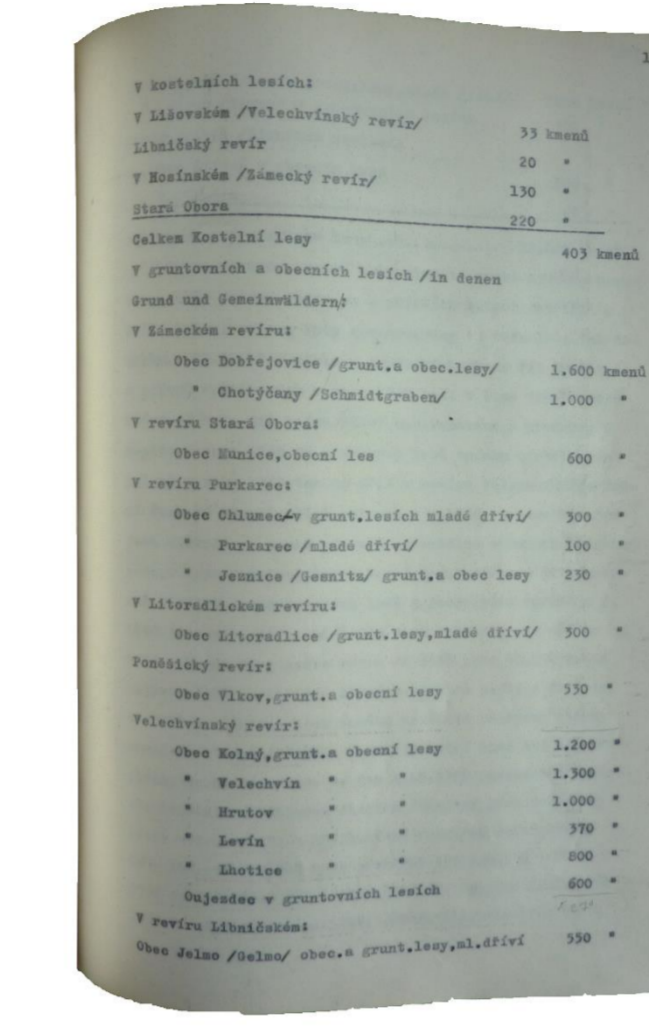


Fig. 3 Historical research into forests related to damage caused by windstorm on 20 December 1740 at the Hluboká nad Vltavou estate (Paukner and Kruml, 1959)



Fig. 4 Front title page of Prager Zeitung from 26 August 1816 (S2)

Methods

Many of these records were hand-written in neo-Gothic italic script in German (in more recent times also in Czech). The information related to strong winds was carefully transliterated and excerpted and the database of strong winds was created. Where possible, individual records were checked by cross-referencing to other evidence. Strong winds were classified from squalls, tornadoes, strong winds/blizzards, gales, windstorms and strong winds of uncertain type. Individual events, dates of occurrence, settlements affected, the type and extent of damage and source of data became the basic information for further critical analyses and interpretations.

Results

Frequency of strong winds

Based on the documentary evidence, 4 329 events of strong winds were identified between AD 1510 and 2017. Strong winds were attributed to six different types of events: gales (39.9%), strong winds/blizzards (28.5%), squalls (19.7%), tornadoes (8.0%), windstorms (1.9%) and strong winds of uncertain type (1.8%) (Fig. 5a, b).

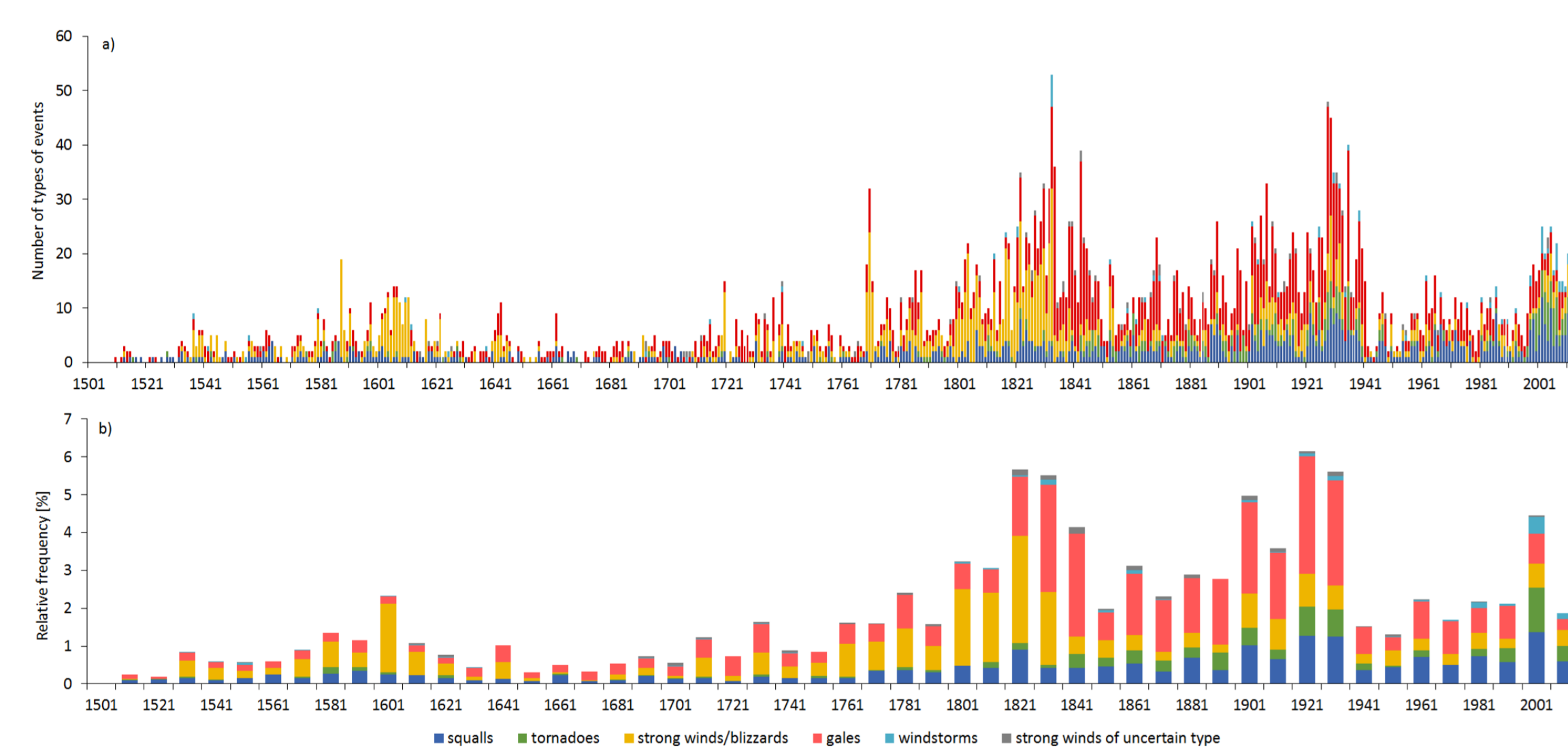


Fig. 5 Annual (a) and decadal (b) frequency of types of strong winds in the Czech Lands during the 1510-2017 period

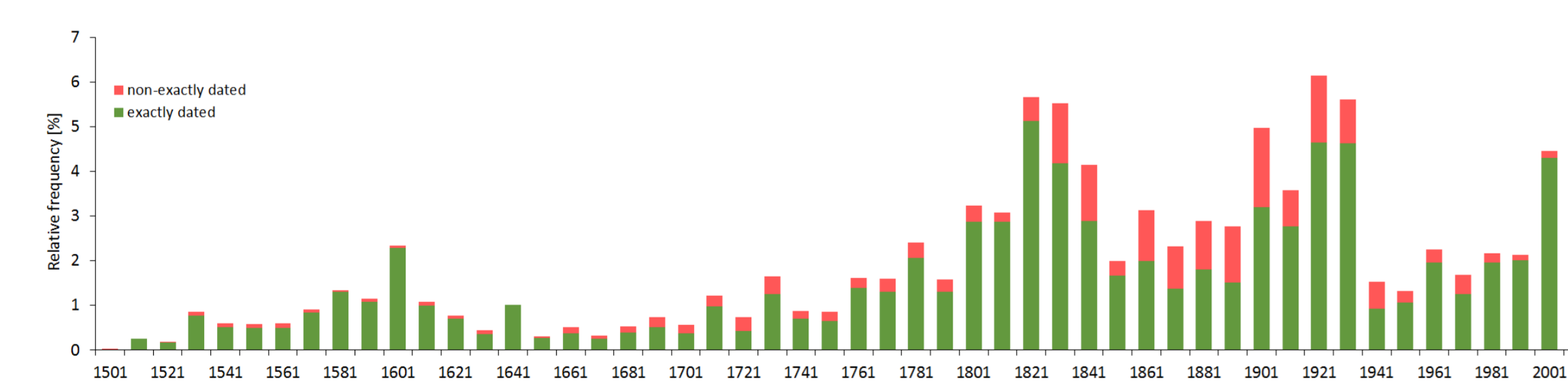


Fig. 6 Decadal frequencies of strong winds for exactly and non-exactly dated events in the Czech Lands during the 1510-2017 period

Temporal variability of strong winds

Strong winds detected were concentrated mainly from the 1820s to the late 1840s, from the 1900s to the late 1930s and in the 2000s. The mean annual number of strong winds during 1510-2017 period (508 years) counts 8.5 events. Because strong winds were recorded only during 476 years, it represents in mean 9.1 events per year (with strong wind). The annual maximum of strong winds was recorded in 1833 (53 events). Regarding accuracy of dating, 80.2% of all strong winds events were exactly dated with accuracy for day and month and 19.8% of events were non-exactly dated (Fig. 6). In terms of annual variation, July (10.6%) with the most frequent strong wind events was followed by January (8.9%), June (8.4%) and August with December (8.2% each), i.e. 44.4% of all events occurred in these five months (Fig. 7). In term of seasonal frequencies, summer (27.5%) was followed by winter (24.9%), spring (20.4%) and autumn (14.3%) (Fig. 8). The highest frequency of strong winds was recorded in the 19th century (32.0%) followed by 20th (30.8%) and 18th (13.5%) centuries (Fig. 9).

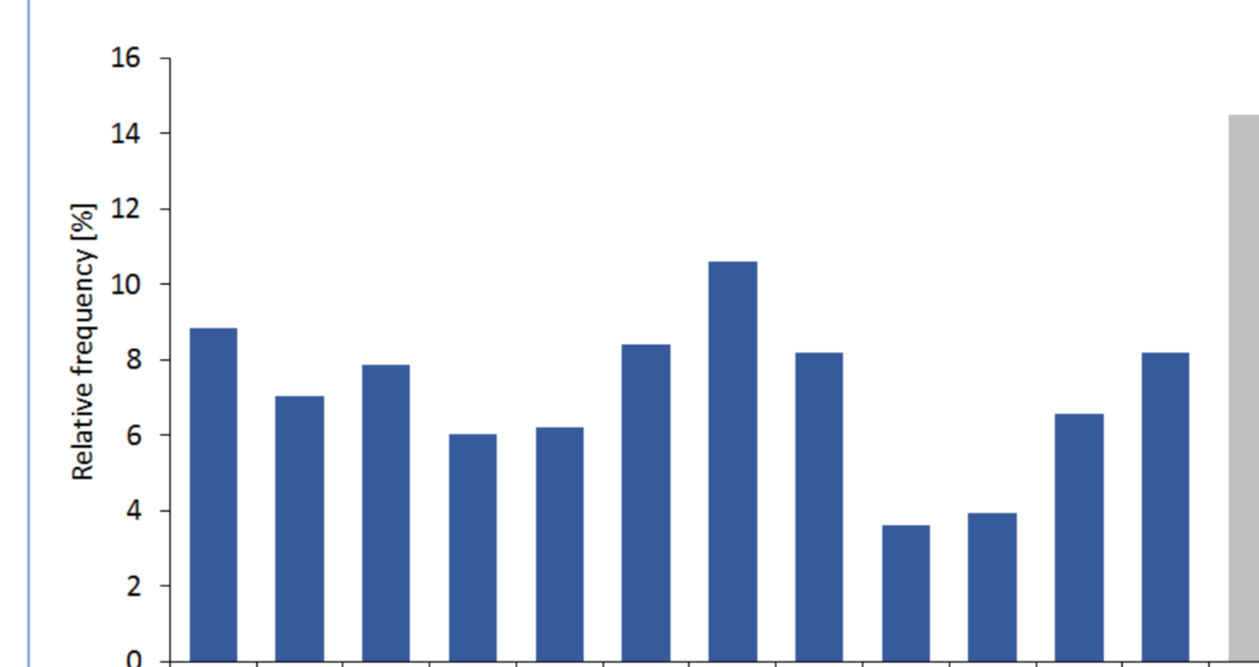


Fig. 7 Monthly frequencies of strong winds in the Czech Lands during the 1510-2017 period (X - non-exactly dated events)

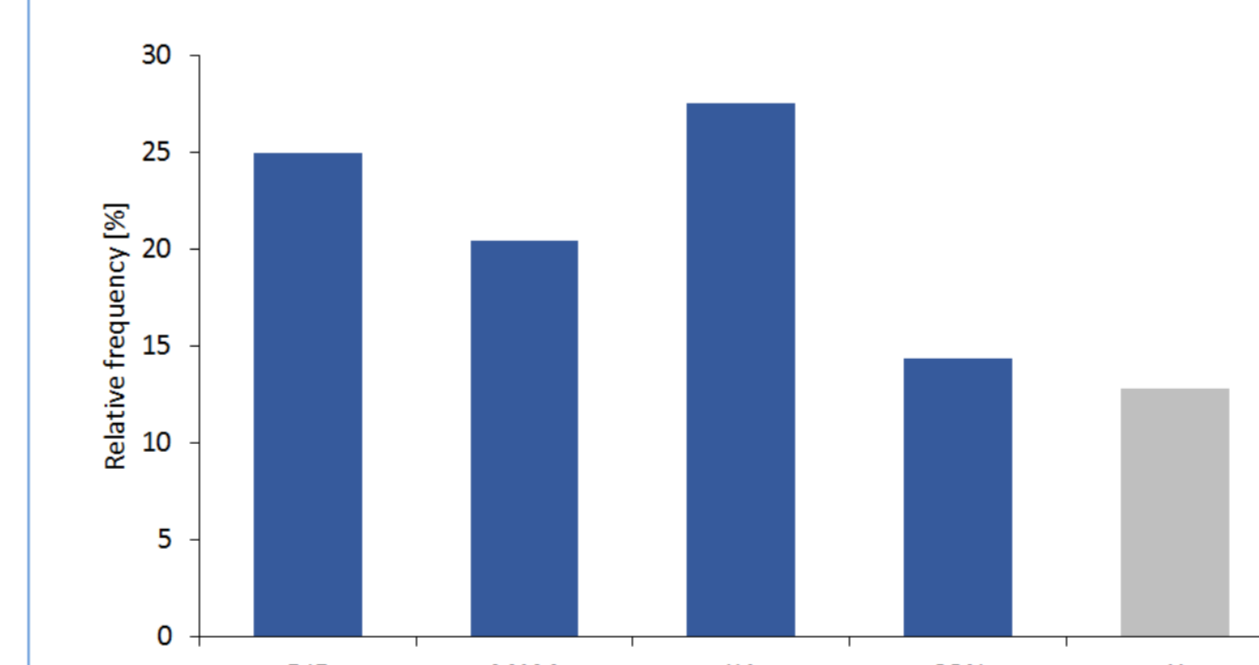


Fig. 8 Seasonally frequencies of strong winds in the Czech Lands during the 1510-2017 period (X - non-exactly dated events)

Historical research into forests

Special attention was focused on temporal distribution of historical research into forests as one of the most utilise type of documentary evidence. The maximum records of strong winds described by historical research into forests was reported in the 1900s (12.0% of all historical research into forests) followed by 1920s (10.9%) and 1890s (10.7%) (Fig. 11).

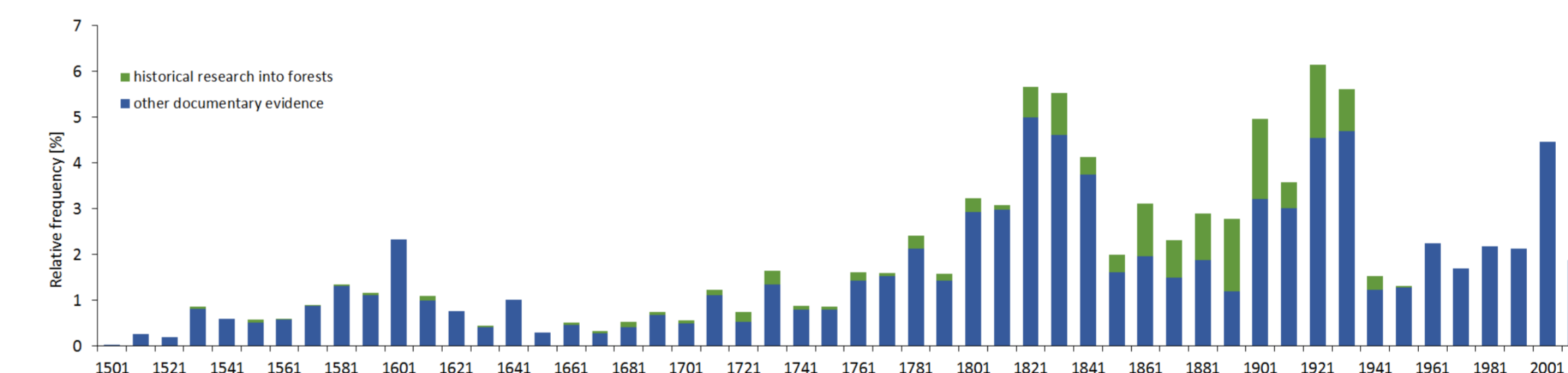


Fig. 11 Decadal frequencies of strong winds according to used historical research into forests and other documentary evidence in the Czech Lands during the 1510-2017 period

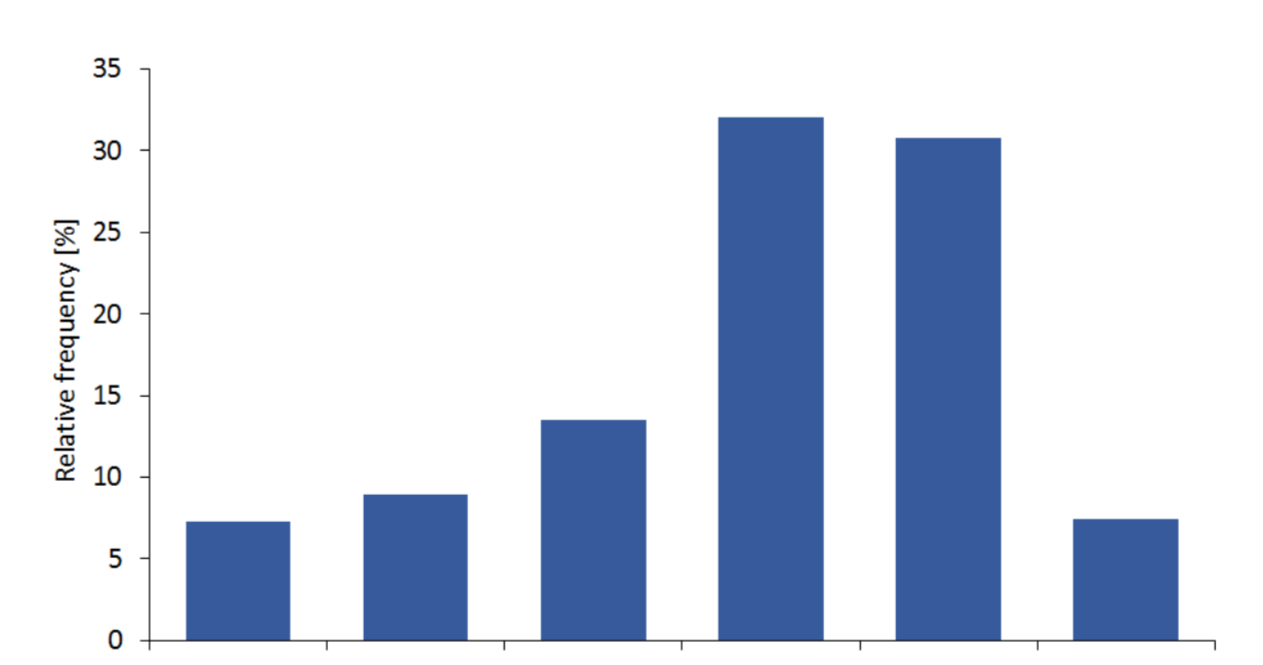


Fig. 9 Centennial frequencies of strong winds in the Czech Lands during the 1510-2017 period

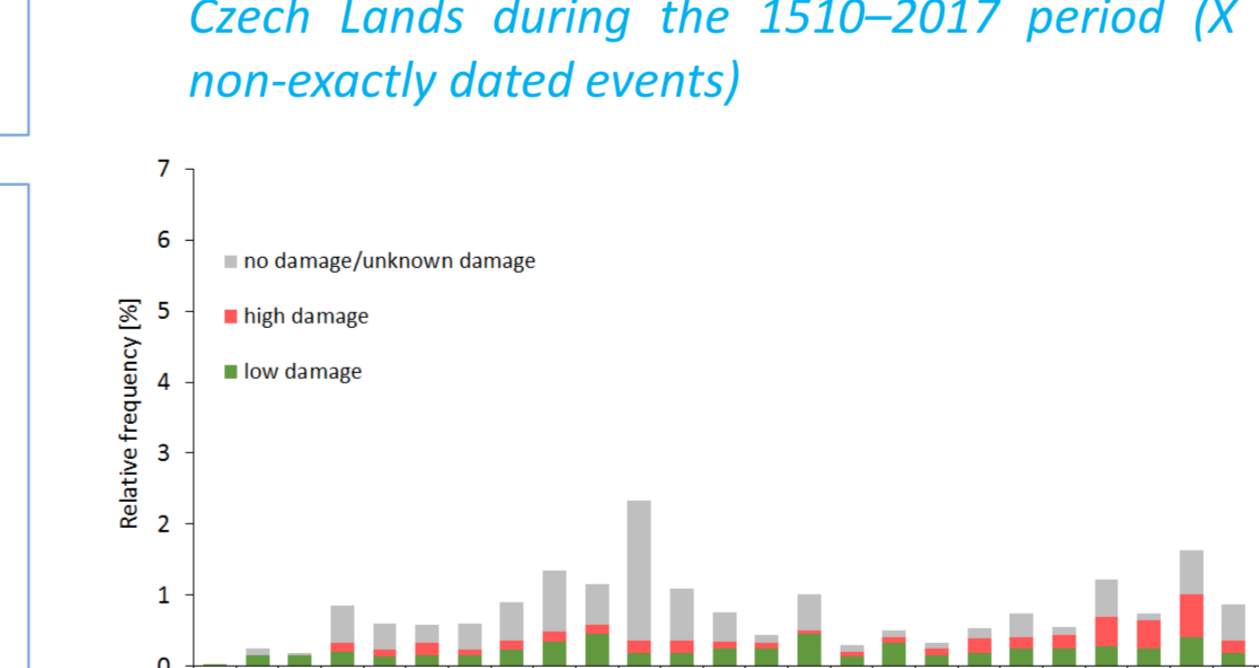


Fig. 10 Decadal frequencies of damage extent caused by strong winds in the Czech Lands during the 1510-2017 period

Database of strong winds

The database was used for compilation of various long-term chronologies of strong winds for the territory of the Czech Lands from AD 1510 (e.g. Brázdil et al. 2018a, b) or served as a main source of information for detailed case studies of extraordinary windstorms of the 18th and 19th centuries (e.g. Brázdil et al. 2017a, b, c).

Discussion

Results presented can be partly influenced by uncertainties related to:

- inaccurate dating of some strong winds,
- uncertainty in the type of some strong winds,
- unequal information potential of different documentary records (e.g. historical research into forests dates exactly only 25.6% events with daily accuracy but half of the historical research into forests expresses corresponding damage quantitatively).

Conclusions

The paper presents preliminary results of the temporal analysis of 4 329 events of strong winds in the Czech Lands from AD 1510 to 2017 (508-year chronology). Despite the enormous time effort related with processing of documentary evidence, the presented chronology represents importance of documentary evidence in the study of strong winds and contributes to the better understanding of their temporal variability in the past.

Contact

Lukáš Dolák
Masaryk University
Email: dolak@sci.muni.cz
Phone: +420 549 494 378

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Archival sources

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S2 Österreichischen Nationalbibliothek, Prager Zeitung, No. 239, 26 August 1816, p. 949.
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