PAST HYDROMETEOROLOGICAL EXTREMES IN SOUTH-WESTERN MORAVIA (CZECH REPUBLIC) DERIVED FROM TAXATION RECORDS

KATEŘINA CHROMÁ (1), RUDOLF BRÁZDIL (2,1), HUBERT VALÁŠEK (3), PAVEL ZAHRADNÍČEK (1,4) and LUKÁŠ DOLÁK (2)

chroma.k@czechglobe.cz

(1) Global Change Research Centre AS CR, Brno, Czech Republic

(2) Institute of Geography, Masaryk University, Brno, Czech Republic

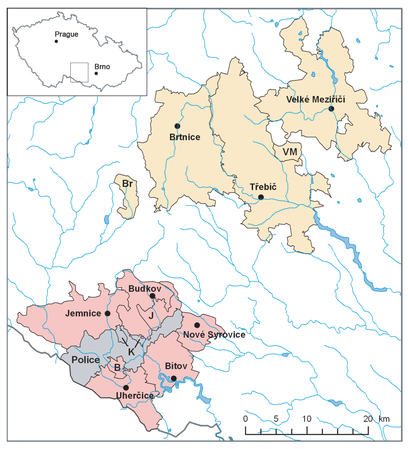
(3) Moravian Land Archives, Brno, Czech Republic

(4) Czech Hydrometeorological Institute, Brno, Czech Republic

INTRODUCTION

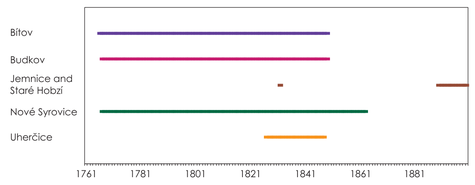
Hydrometeorological extremes (HMEs) always influenced human activities, such as agriculture, forestry, water management, and caused great material damage or even loss of human lives. In the Czech Lands (recently the Czech Republic), systematic meteorological and hydrological observations started generally in the latter half of the 19th century. In order to create long-term series of disastrous hydrometeorological phenomena, it is necessary to search for other sources of information for their study before 1850. Direct and indirect information about these phenomena is included in documentary evidence, e.g. chronicles, diaries, early visual weather observations, newspapers, economic sources etc. Documentary evidence of economic character belongs to the most important sources, especially documents related to taxation records. Damage to agricultural crops on the fields or damage to hay on meadows due to the hydrological and meteorological phenomena has been a good reason for the abatement of tax duty. Also various reports of administrators of estates to the holders could contain information about damage caused by these phenomena. The paper deals with official correspondence of five estates located in south-western Moravia (Bítov, Budkov, Jemnice and Staré Hobzí, Nové Syrovice and Uherčice). The documents give information about the type of phenomena (flood, flash flood, torrential rain, hailstorm, thunderstorm, windstorm), date of the occurrence, course and corresponding impacts. Created series of individual extremes are used for the study of their fluctuations in the context of past and present climate variability.

STUDIED AREA



Basic information about the five estates studied (natural disaster records also include fire). The area reflects the situation in 1834 (Wolny and Schenkl, 1846).

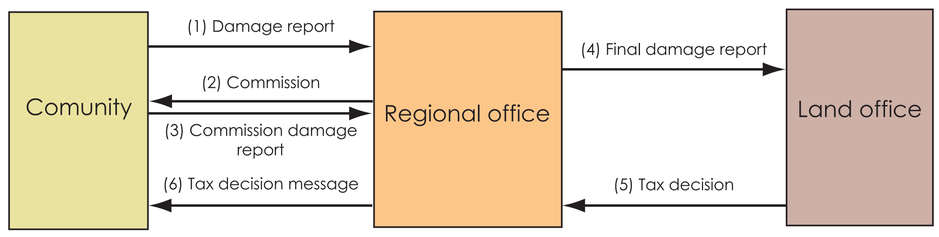
Estate	Area (ha)	Period of estate documents	Natural disaster records	Number of HMEs
Bítov	5 840	1640–1931	1766–1849	45
Budkov	4 644	1513–1943	1767–1849, 1910–1933	15
Jemnice and Staré Hobzí	10 960	(1490) 1589–1945	1832, 1890–1923	11
Nové Syrovice	1 935	(1671) 1703–1943	1767–1863	8
Uherčice	6 004	1628–1949	1827–1848	12



Time range of availability of records concerning natural disasters at five estates studied in the period 1761-1900

Location of estates studied (rose) with their administrative centres. The estates studied by Dolák et al. (2013), used for comparison, are also included (orange). No direct information of HMEs is available for the Police and Kdousov estates (grey) (B - Bítov estate, Br - Brtnice estate, J - Jemnice estate, K - Kdousov estate, VM - Velké Meziříčí estate).

DOCUMENTARY EVIDENCE RELATED TO THE TAX ALLEVIATION



The process of tax alleviation related to damage arising out of HMEs. The numbers express the temporal sequence of individual steps in the process (adapted after Dolák et al., 2013).

Not all types of documents are available for individual HMEs

Usually available types of documents:

information about a damage on fields, meadows or grazing land due to a weather disaster (1) → official delegation of the commisioners designated to inspection and evaluation of the reported damage (2) → official record about the procedure of the inspection and evaluation of the damage (3, 4) → the form with damage listed to individual afflicted farmers (3, 4)

→ decision about permission of tax alleviation and its amount (in some cases filled into the form with listed damage, otherwise not available at this stage of administration) (5, 6)

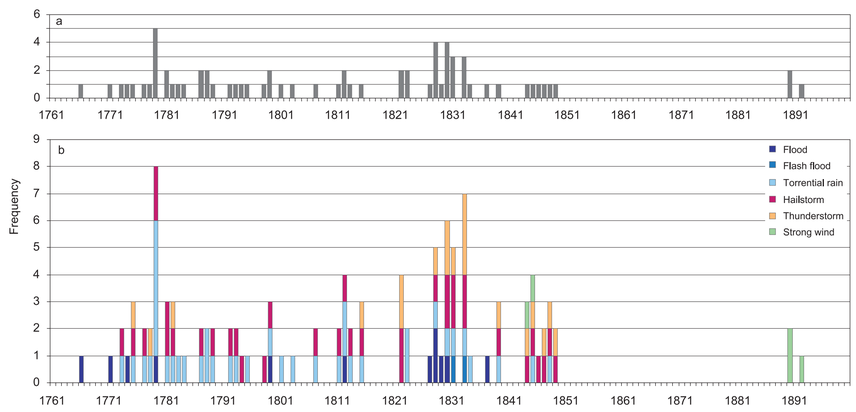
Limitations and uncertainties of taxation records (Brázdil et al., 2012):

- spatial and temporal uncertainty (density of records reflects the number of surviving documents)
- uncertainty in the annual distribution (damage to agricultural crops - vegetation period, stages of crop phenophase)
- uncertainty as to the type of extreme (dependent on the observational talent and literacy)
- uncertainty about the damage done (only events with damage high enough for entitlement to tax relief are recorded)

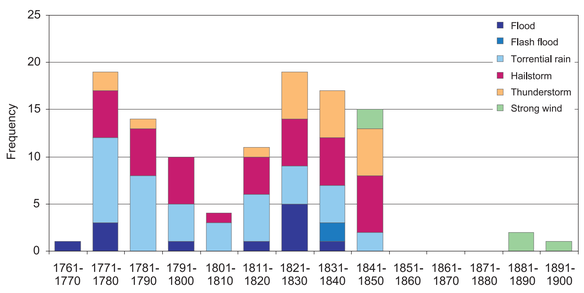
HYDROMETEOROLOGICAL EXTREMES IN SOUTH-WESTERN MORAVIA IN 1761-1900

TEMPORAL ANALYSIS

totally **69 HMEs** recorded
113 types of HMEs (e.g. one event of thunderstorm accompanied by hailstorm and torrential rain causing a flash flood is divided into four single phenomena)

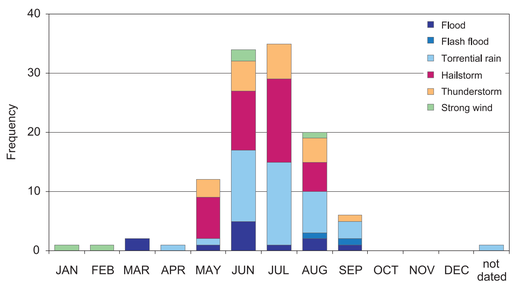


Annual frequency of (a) HMEs and (b) individual types of HMEs in south-western Moravia in the 1761-1900 period



	Flood	Flash flood	Torr. rain	Hailstorm	Thunderst.	Strong wind	sum	%
1761-1770	1	0	0	0	0	0	1	0.9
1771-1780	3	0	9	5	2	0	19	16.8
1781-1790	0	0	8	5	1	0	14	12.4
1791-1800	1	0	4	5	0	0	10	8.8
1801-1810	0	0	3	1	0	0	4	3.5
1811-1820	1	0	5	4	1	0	11	9.7
1821-1830	5	0	4	5	5	0	19	16.8
1831-1840	1	2	4	5	5	0	17	15.0
1841-1850	0	0	2	6	5	2	15	13.3
1851-1860	0	0	0	0	0	0	0	0.0
1861-1870	0	0	0	0	0	0	0	0.0
1871-1880	0	0	0	0	0	0	0	0.0
1881-1890	0	0	0	0	0	2	2	1.8
1891-1900	0	0	0	0	0	1	1	0.9
Total	12	2	39	36	19	5		
%	10.6	1.8	34.5	31.9	16.8	4.4		

Decadal frequency of individual types of HMEs in south-western Moravia in the 1761-1900 period



	Flood	Flash flood	Torr. rain	Hailstorm	Thunderst.	Strong wind	sum	%
January						1	1	0.9
February						1	1	0.9
March	2						2	1.8
April			1				1	0.9
May	1		1	7	3		12	10.6
June	5		12	10	5	2	34	30.1
July	1		14	14	6		35	31.0
August	2	1	7	5	4	1	20	17.7
September	1	1	3		1		6	5.3
October							0	0.0
November							0	0.0
December							0	0.0
not dated			1				1	0.9

Annual distribution of HMEs in south-western Moravia in the 1761-1900 period

The most frequent types of HMEs:

- torrential rain (34.5%)
- hailstorm (31.9%)
- thunderstorm (16.8%)
- flood (10.6%)

The less frequent HMEs:

- strong wind (4.4%)
- flash flood (1.8%)

Other extremes (not included in the number of HMEs): strong wind or drought (causing fast spreading of fire), rainy weather (damage on hay), bad harvest, etc.

Months with the highest frequency of HMEs:

- June (30.4%)
- July (26.1%)
- August (15.9%)
- May (13.0%)

Months with the highest frequency of types of HMEs:

- July (31.0%)
- June (30.1%)
- August (17.7%)
- May (10.6%)

Distribution of HMEs during the year shows their close connection to the most frequented occurrence of convective phenomena in the vegetation period (April-September)

SPATIAL ANALYSIS OF SETTLEMENTS AFFECTED

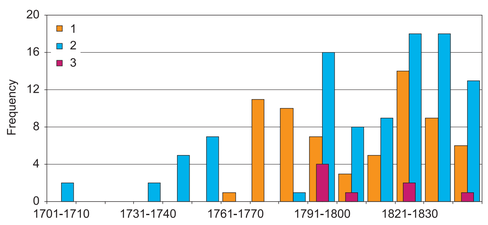
HMEs reported for the highest number of settlements:

- 1778, 15 August - thunderstorm with torrential rain - 7 settlements (2 estates)
- 1782, 29 July - thunderstorm with torrential rain and hailstorm - 7 settlements (2 estates)
- 1789, 13 July - torrential rain and hailstorm - 8 settlements (2 estates)
- 1828, 26 August - 7 September - long-lasting rain and flood - 7 settlements (2 estates)
- 1830, 26 May - thunderstorm with hailstorm - 8 settlements (3 estates) + information about another 4 settlements at 1 neighbouring estate
- 1833, 1 July - thunderstorm with hailstorm - 8 settlements (3 estates) + information about another 4 settlements at 1 neighbouring estate
- 1833, 20 September - thunderstorm with hailstorm and flash flood - 8 settlements (1 estate) + information about another up to 10 settlements at 1 neighbouring estate
- 1839, 5 August - thunderstorm with torrential rain and hailstorm - 8 settlements (3 estates) + information about 1 another settlement at 1 neighbouring estate
- 1845, 9 June - thunderstorm with torrential rain, hailstorm and windstorm - 7 settlements (4 estates) + information about another 2 settlements at 2 neighbouring estates
- 1848, 20 June - thunderstorm with torrential rain and hailstorm - 9 settlements (3 estates) + information about another 15 settlements at 3 neighbouring estates

Number of affected settlements	Number of HMEs	%
1	16	23.2
2	14	20.3
3	8	11.6
4	9	13.0
5	4	5.8
6	4	5.8
7	4	5.8
8	5	7.2
9	1	1.4
undecided	4	5.8

HMEs affecting corresponding number of settlements in south-western Moravia in the 1761-1900 period

COMPARISON with Dolák et al. (2013)



Decadal frequency of HMEs in the current paper (1) in comparison with Dolák et al. (2013) (2). The concurrent occurrence of HMEs in the two areas is also shown (3)

Decade	Number of HMEs		
	Current paper	Dolák et al. (2013)	Common cases
1701-1710		2	
1711-1720		0	
1721-1730		0	
1731-1740		2	
1741-1750		5	
1751-1760		7	
1761-1770	1	0	
1771-1780	11	0	
1781-1790	10	1	0
1791-1800	7	16	4
1801-1810	3	8	1
1811-1820	5	9	0
1821-1830	14	18	2
1831-1840	9	18	0
1841-1850	6	13	1
1851-1860	0		
1861-1870	0		
1871-1880	0		
1881-1890	2		
1891-1900	1		

Comparison of current analyses with three other estates located more to the north in the Bohemian-Moravian Highlands (Brtnice, Třebíč and Velké Meziříčí, see map) worked by Dolák et al. (2013) show the spatial and temporal uncertainty of HMEs derived from taxation records - may be related also to areally limited convection

CONCLUSIONS

Based on the official correspondence of five estates located in south-western part of Moravia, archival information about taxation from the Moravian Land Archives in Brno was excerpted. Based on it, 69 disastrous events (113 individual types) resulting in some kind of damage are documented for 1761-1900. Their temporal distribution is very variable with highest concentration between 1771-1799 and 1822-1849 (82.6% of all events). Reports of damage due to torrential rain were the most frequent, with damage on harvest or directly on fields. Hailstorms were the second most frequent and damaged damaged (often very significantly) or destroyed the harvest. Thunderstorms were the third most frequent but their number is underestimated (hailstorms and torrential rains are related to convection but it was not pointed out in the original records).

This case study, confined on a small area, demonstrates the high potential of historical taxation records as an important source of data for historical climatology and hydrology in the Czech Republic and in other European countries.

REFERENCES:

BRÁZDIL, R. - CHROMÁ, K. - VALÁŠEK, H. - DOLÁK, L. (2012). Hydrometeorological extremes derived from taxation records for south-eastern Moravia, Czech Republic, 1751-1900 AD. Climate of the Past, 8(2), 467-481.

DOLÁK, L. - BRÁZDIL, R. - VALÁŠEK, H. (2013). Hydrological and meteorological extremes derived from taxation records: the estates of Brtnice, Třebíč and Velké Meziříčí, 1706-1849. *Hydrological Sciences Journal*, accepted.

WOLNY, G. - SCHENKL, K., 1846. Die Markgrafschaft Mähren. Topographisch, statistisch und historisch geschildert. III Band. Znaimer Kreis. Karl Winiker, Brünn, 581 pp.

ACKNOWLEDGEMENTS: This poster has been prepared with the financial support for the projects No. 13-19831S (Grant Agency of the Czech Republic) and No. CZ.1.05/1.1.00/02.0073 CzechGlobe (Ministry of Education, Youth and Sports of the Czech Republic).