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Climate of the Past Discussions

Interactive comment on "Low Water Stage Marks on Hunger Stones: Verification for the Elbe River in 1616–2015" *by* Libor Elleder et al.

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Libor Elleder (CA): Answers to Neil Macdonald (NM)

NM The paper is worthy of publication, however as a native English speaker it requires considerable work to ensure that the paper is articulating the findings clearly and concisely. I have attempted to help with the annotated comments; however, I am unable to work through the whole paper in detail because of time constraints, this requires extensive reworking. 1/ I would recommend reviewing the sub-heading titles and shortening them in places e.g. 5.1 is too long.

CA The text was proofreded and by a native spakerm a professional proofreader.

NM Figure 4: it would be helpful to have a full image of the stone as an insert de-

picting the four sections, and then present these four sections as you have them - the combined image is embedded in Table 4.

CA: This is a good idea. Unfortunately, the pictures available are very similar to the upper part of the scan in Fig., 4 however due the confusing shadows and light and bad reading of the marks are not suitable for publication.

Dear reviewer, I hope , I accepted and corrected all points you highlighted.

NM, Line 19

CA: OK The greater documentary value, "documentary" was deleted Our aim was, among other issues, to draw attention to the much greater value of hunger stones and individual dry year marks inscribed on them. NM Line 22-23

CA: Thanks to the helpful position of the stones relative to the water gauge, we could compare the measured mark heights to the corresponding water levels. NM Line 30-31

CA: To verify the low water level marks or drought marks (DM) we used the then current scientific studies focussing on dry periods. NM Line 33-35

CA: However, we also used the oldest series of daily water levels measured in Magdeburg, Dresden and Prague, available from 1851, i.e. the beginning of measurements in Děčín. These series had to be reconstructed or digitised from CHMI archive sources

However, we also used the oldest series of daily water levels measured in Magdeburg, Dresden, and Prague, available from 1851, i.e. by the beginning of measurements in Děčín. NM: Line 36-37

CA: After a thorough field examination and newly measured data, coupled with data obtained from a review of older literature presenting the first surveys of marks on hunger stones as presented in 1842, older marks of low water levels can be considered as a reliable indication of the annual water level minima. NM: Lines 39-40

CA: The aim of the mark creators was not to make commemorative inscriptions of

droughts, but to register the exact minimum water level. Deviations between the marks and the water gauge records did not exceed 4 cm, in the worse case the water level was 8 cm and only exceptionally was the disparity greater. NM: Lines 43-45 ; CA: From the material obtained so far, an overall slightly decreasing trend of water level minima since the end of the 18th century is noticeable. The view on minima of the 17th and 16th centuries is based on only a few items of data and it is difficult to generalise. NM Lines 46-47

CA: Our verification of low water level marks should be an incentive to process all available epigraphic documents of this kind in the near future in closer cooperation with colleagues from Saxony.

NM:Lines 54-56

CA: In recent years, the phenomenon of drought has become the most prominent manifestation of climate change in Central Europe. However, objective evaluation and assessment of its extremity is challenging, due to difficulty in describing the phenomenon of drought and the varying impacts of it. Drought, along with floods, ranks among the most commonly evaluated hydrological extremes.

NM: Lines 56-58

CA: While a flood is caused by an unexpected and short-term excess of water that causes damage, hydrological drought follows a long-term deepening of water scarcity. NM Lines 59-64

CA: Our contribution is focused on hydrological drought, more precisely on the minima of low levels. Low water level and flow rates after long periods of precipitation deficit represent particularly valuable information about catchment hydrology. Therefore, they also report on the base-flow, the groundwater accumulation, long-term depletion and hydrological drought propagation (van Loon, 2015). The minimum water level or flow is, to a large extent, summary information on the status of a given river basin.

NM: Lines 67-74

CA: The longest hydrological series of measurements in Cairo, A.D. 622- A.D. 1933, representing 1,311 years of Nile observation (Shanin, 1985), was used to assess drought and its interrelations with phenomena such as El Niño. In Europe, the longest continuous series comprising measurements of water levels, in Magdeburg, started in 1726 (see the following text), and the measurements in Paris started in 1731 (Delametherie, 1800). However, it is impossible to conceal another complication, namely that systematic hydrometric measurements have, for the most part only been available since the end of the 19th century. Stable profiles where we can assume the validity of the rating curve as far back as possible are very valuable. Systematic series of water stages are, therefore testimony on runoff fluctuations, but partly also on changes in the stream cross-section and the catchment, both natural and anthropogenic.

NM Lines 75-77:

CA: Systematic series of water stages are, therefore testimony on runoff fluctuations, but partly also on changes in the stream cross-section and the catchment, both natural and anthropogenic.

NM, Line 78-80:

CA: Studies that focus on the identification of past dry periods and possibly on the wider context within NAO, ENSO oscillations are based mostly on an analysis of precipitation deficit or indicators that include temperature and hence loss by evaporation (e.g. MikšovskÃ¡ et al., 2019).

NM, Lines 82-84

CA: However, if we want to describe how the rainfall deficits and other weather influences were reflected in the runoff from the surveyed river basin, the options we have so far are rather limited.

NM, Lines 87-88

CA With the help of deficit volume analysis with a fixed annual (Q95) and variable monthly threshold (Q95m), Brazdil et al. (2015) identified the drought events of 1868 and 1874 as comparable to the 1904, 1911 and 1947 dry periods. NM, Lines 90-94

CA The authors elaborated in detail the selected dry years of 1808, 1809, 1811, 1826, 1834, 1842, 1863, 1868, 1904, 1911, 1921, 1934, 1947, 1953, 1959 and 2003, i.e. 8 cases in each century representing a total of 16 cases selected on the basis of the lowest Z-index and SPI1 values out of 10 homogenised precipitation series (Brázdil et al., 2012). The evaluation of particular years includes the meteorological and synoptic conditions, drought impacts, monthly values of air temperature, precipitation, SPI1, SPEI1 and Z-index. In the identification of hydrological drought in the 1860s and 1870s, a similar result was reached by Elleder et al. (2019) when analysing the catastrophically dry year 1874 by analysing the newly reconstructed series of water levels in Prague (1825-1890).

Remark: In this study was used standardized precipitation SPI-1 index for month to evaluate yearly distribution of precipitation in selected years

NM, Lines 97-101

CA: I included two of citations: Wilhelm et al (2019) and Schulte et al (2019)

But what credible documents of low water levels existed before 1851 (the start of record-keeping in Děčín), 1825 (the start of record-keeping in Prague) or 1727 (the start of record-keeping in Magdeburg)? Based on reconstructed data on temperatures and precipitation between 1766 and 2015, Hanel et al. (2018) indicated extreme deficits in precipitation, runoff and water content of the soil surface layer, identifing the droughts of 1858-1859, 1921-1922 and 1953-54 as extreme. However, there is no doubt, similar to flood analysis, that verifying the model results according to the actual water level and flow rate increases their credibility considerably. We have a relatively large range of palaeostage indicators to describe the maximum water levels during a flood. These palaeoflood indicators comprise various types of sedimentary (e.g. slack-

water flood deposits) and botanical evidence such as impact marks and damage on trees (Benito et al., 2004, 2015, Wilhelm et al., 2019, Schulte et al. 2019). NM Lines 107-116

CA: Therefore, low water level indicators available through documentary sources are unique data records (Brazdil et al., 2018) for recording past hydrological droughts, with the precision given by physical imprints provided by epigraphic marks. During the drought, attention was paid to objects normally hidden below the water level. Most often these were large boulders, protruding rocks and sometimes even point bars or slip-off slope sandy deposits with specific local names. In many cases these were also artificial objects, protruding foundations of old bridges and building elements; around the Rhine these were the remains of old buildings or old bridges etc. (Wittman, 1859). Sometimes there was an interesting local tradition; in the sandstone area on the Czech/Saxon border it was the creation of commemorative inscriptions, particularly inscribing the current year with the low water level. Today, these objects are mostly called hunger stones.

Lines 117-119 NM:

CA: This article focuses on these hunger stones; it seeks to clarify their purpose, origin and meaning. Traditionally, water management experts and historians and perhaps ethnographers in Bohemia considered inscriptions and the year as indicated on hunger stones to be an interesting phenomenon symbolising drought.

CA: We have therefore focussed on the city of Děčín, located in the lower section of the Czech part of the Elbe river basin. The best-known hunger stone is located here and all important height surveying of all the epigraphic marks was undertaken in the summer of 2015. In 2018 the whole stone was scanned. This article discusses to what extent the inscription years have the character of historical minimum water levels.

NM

Objectives 1. To document and explain the phenomenon of hunger stones in more detail. 2. Are the year marks only commemorative for that dry year and when do they represent exact records of annual minimum water levels? 3. Are there consistent relations in the heights of stage minima among different stones? 4. What is the relation to the systematic series of measurements? 5. Do the elevations suggest any trend in water levels?

NM, lines 138-142

CA: Following the reviewer (R1) advice I changed the title The Elbe river valley between Litoměřice and Pirna was made famous by a number of prints and paintings by 19th century Romantic painters such as Adrian Zinggs (1734 – 1816) and Caspar David Friedrich (1774 – 1840). Zinngs was Swiss, but lived in Dresden; he probably coined the name of the Saxon Switzerland region, which later extended to Czech âĂŤ Saxon Switzerland (Frölich – Schauseil, A., 2018). NM, lines 147-152

CA: In addition to wood, local sandstone was a traditional building and sculptural material here and throughout the North Bohemian region. However, it was also used for rich epigraphic production on the spot âĂŤ on rocks and boulders (Jenč, Peša, Barus, 2008). It is quite logical that water levels were recorded adjacent to the river where possible, both minima and maxima.

CA: At the centre of our study is the city of Děčín (Fig. 1), known among other things for its unique series of flood marks (Brázdil et al., 2005, Elleder, 2016a) and hunger stone. The earlier documentation, which comes from commission inspections of the Elbe riverbed revealed previously unknown facts. In 1842, there were still a total of three hunger stones in the city of Děčín with engraved years, two on the left bank [HS1, HS3] and one on the right bank upstream of the ferry crossing [HS2] (Protokoll, 1842). The preserved stone [HS3] which is located in the lower part of the deeper riverbed is the centre of our attention. NM: lines 165-168

CA. It is related to the confluence of the Elbe River with the Ploučnice River entering

from the right, the JílovskÃ¡ potok stream from the left and the sediment deposits.

NM: lines 168-174

CA: This place was probably advantageous long ago as a settlement with a ford at the river confluence and below the protruding sandstone ridge. At the end of the 13th century a royal town was founded here (Fig.1, VelimskÃ¡, 1991). Possibly in connection with the period of a significant occurrence of floods between 1342 and 1374 (Elleder, 2015), it was abandoned and transferred to the other side of the rock ridge, where a castle stood and the manor house is situated nowadays. There were at least two places in Děčín that were problematic from a navigational point of view. The first hunger stone [HS1] was located near the first water shallows area.

Please also note the supplement to this comment:
https://www.clim-past-discuss.net/cp-2019-113/cp-2019-113-AC1-supplement.pdf

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