Original scientific article
Received: 2015-06-24

UDK 661.42:551.583.2(497.4Sečovlje)«1645/1715«

AN ATTEMPT TO DEMONSTRATE THE INFLUENCE OF MAUNDER MINIMUM CLIMATE ON SALT PRODUCTION AND IT'S PRICE IN THE SLOVENIAN ISTRIA (SEČOVLJE SALT-PANS)

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ABSTRACT

This paper investigates the harvest of sea salt in the former Pirano Commune from 1637 to 1744 under the rule of the Venetian Republic. The period from 1645 to 1715 coincides with the so called Maunder minimum when minimum solar activity was detected. As the indicator of solar activity the sunspot numbers were used. The paper reviews different historical climate records and presents the results of empirical analysis of possible relationship between solar activity during the Maunder minimum and salt production, as well as its price. The results imply a causal connection between solar activity and salt price series, but the problems with the unreliable and short time series and missing data compelled our research to use statistical methods that might produce inconsistent and spurious results.

Key words: Maunder minimum, sunspot number, solar activity, climate in pre-instrumental period, salt production, Sečovlje salt-pans

TENTATIVO DI DIMOSTRARE L'INFLUENZA DEL CLIMA DURANTE IL MINIMO DI MAUNDER SU PRODUZIONE E PREZZO DEL SALE NELL'ISTRIA SLOVENA (SALINE DI SICCIOLE)

SINTESI

L'articolo esamina la raccolta del sale marino nell'ex Comune di Pirano dal 1637 al 1744, sotto il dominio della Repubblica di Venezia. Il periodo 1645-1715 coincide con il cosiddetto minimo di Maunder, quando fu registrato il minimo dell'attività solare. Il numero di macchie solari è stato usato quale indicatore dell'attività solare. Diverse registrazioni climatiche storiche sono state esaminate e vengono presentati i risultati dell'analisi empirica della possibile relazione tra l'attività solare durante il minimo di Maunder e la produzione ed il prezzo del sale. I risultati implicano un nesso causale tra l'attività solare e la serie dei prezzi del sale, ma i problemi legati alle brevi e poco affidabili serie storiche nonché i dati mancanti hanno portato gli autori all'uso di metodi statistici che potrebbero aver prodotto risultati inconsistenti e fuorvianti.

Parole chiave: Minimo di Maunder, numero di macchie solari, attività solare, clima nel periodo pre-strumentale, produzione del sale, saline di Sicciole

INTRODUCTION

It is commonly known that salt production by solar evaporation of brine is highly dependent on the weather, mainly on solar irradiance (clouds), rainfall and wind. Rainfall during the salt harvesting season and extended winters, as well as lower summer temperatures can cut down the harvest of salt. In his model of solar brine evaporation, Akridge (2008) stresses the importance of high sunlight duration and its intensity, and low relative humidity and rainfall in traditional salt making procedures. The aim of this article is to search for possible connections between weather conditions during the Maunder minimum (hereafter referred to as the MM) and salt production in the Sečovlje salt-pans, as well as its price. During the time of the MM, the Slovenian Istria was part of the Venetian Republic. In the Venetian Republic, salt was one of the most important trading goods and consequently the reason for numerous wars. As one of the state monopolies, salt production and trade were carefully monitored and its prices were strictly regulated by the Salt Magistracy (Magistrato al Sale). The Piran salt-pans were the largest North Adriatic salt-pans, and after 1460 probably the most important in the entire Venetian Republic (Bonin, 2001; Darovec, 2001).

In 1636, the Salt Magistracy decided that the Piran Commune should harvest 5,200 modio yearly (1 modio = 801 kg). This quantity was the standard until 1749, when this limit was abolished. The Salt Magistracy also regulated the price of the harvested salt (Bonin, 2001). We would like to point to the fact that at the beginning of the MM salt price increased twice (1650, 1664) and remained high until the end of the MM when it decreased. Such price fluctuation could suggest a connection between salt price and low solar activity during the MM. The question arises as to whether it is possible that the Venetian Republic incorporated the natural cycles in the state policy, and how the MM influenced the salt harvesting in the Sečovlje salt-pans. In this paper we discuss the possible relationship between salt production and sunspot number, and between sunspot number and salt price. Moreover, the specific focus is on describing the weather conditions in the region during the MM, which might influence the salt production.

Connection between solar activity – climate and between solar activity – agricultural economics

The period from 1645 to 1715 coincides with the MM when minimum solar activity was detected. In history, different indicators have been employed as measures of solar activity. The basic indicator and also the most commonly used parameter is the number of sunspots visible on the solar disk. During the MM, the number of sunspots was the lowest recorded in history; the fact was first recognized by Spörer and later confirmed by other authors (Spörer, 1887; Maunder, 1922; Eddy, 1976; Lean *et al.*, 1995). With the modern era satellite observation, it has been established that the solar irradiance variations are correlated with sunspot number (Wilson & Hudson, 1988, 1991; Frohlich, 2000; Lean, 2001).

Many authors in the past showed a great interest in the reconstruction of the climate during the MM. Some studies rely on historical data (mostly annals, chronicles and historiographical records), while others use various proxies to reflect variations in air and sea temperature. The majority of studies have shown that the MM delineates a period with an increase in climatic variability over Europe and the coldest period of Little Ice Age (Pfister, 1999; Wanner *et al.*, 2000), with extremely cold winters (Pfister, 1994, 1999; Kington, 1995, 1997, 1999; Wanner *et al.*, 1995; Koslowski & Glaser, 1999; Luterbacher, 2000; Luterbacher *et al.*, 2000). The reduction of winter mean temperatures over wide areas of Europe is estimated to be of the order of 1–1.5 °C compared to present levels (Pfister, 1994, 1999; Xoplaki *et al.*, 2001). Estimates of the reduction of solar irradiance are in the order of 0.2 to 0.4 % relative to present levels (Lean & Rind, 1998, 1999).

Several studies reported that the climate during the MM in the eastern and western Mediterranean was generally slightly wetter, colder, and highly variable with severe and more frequent droughts and floods than in the previous century (Barriendos, 1997; Rodrigo *et al.*, 2000; Xoplaki *et al.*, 2001). Similar conclusions for the region of the Slovenian Istria can be drawn from the chronicles of severe weather and climate anomaly conditions, researched by Ogrin (1995). The period was not exceptional in all records context, except for the strong storms with hale and strong wind, which were more frequent during the MM. Ogrin (1995, 2005) also analysed the correlation between salt production in the Sečovlje salt-pans from 1926 to 1937 and from 1946 to 1959 and rainfall occurrence. He found strong inverse correlation ($r > 0.71$, $P < 0.01$) between rainfall occurrence (mm) during the salt harvesting season and salt production (kg/m^2).

In the past, many different authors analysed the correlation between the solar activity and the climate. However, the reported results are contradictive, from strong negative to strong positive correlation, sometimes also no correlation at all was found, depending on the location, the time interval and the analysis technique (Tsiropoula, 2003). The most commonly used meteorological parameters in Sun–weather correlation studies are temperature, rainfall and cloud cover, all very important in production of salt by brine evaporation. Several studies point to the fact that solar activity has a good correlation with the Earth's global climate and temperature (Eddy, 1977; Friis-Christensen & Lassen, 1991; Soon *et al.*, 1996; Baliunas & Soon, 1996; White *et al.*, 1997; Parker, 1999; Baker, 2000; Lean & Rind, 2001; Rozelot, 2001; Tsiropoula, 2003; Tan *et al.*, 2004; Georgieva *et al.*, 2005; Haigh, 2007), and with the Earth's cloud cover (Svensmark & Friis-Christensen, 1997; Svensmark, 1998; Marsh & Svensmark, 2000).

One of the first papers that directly discuss the Sun - climate correlation was published by Koppen (1914), who concluded that there is a negative correlation between the 11-year solar cycle and Earth's mean surface temperature. Similar results were later reported also by Labitzke & Van Loon (1988, 1992) who suggested a correlation between the 11-year solar cycle and a wide range of stratospheric parameters, and by Reid (1991) who found striking similarities between sea surface temperatures and sunspot number solar cycle. Different results were reported also for solar activity and rainfall association. Clayton (1923) determined that continental middle latitude winter precipitations are negatively correlated with solar activity, while summer precipitations are positively correlated with it. Xanthakis (1973) reported a strong positive or negative correlation between precipitation and the 11-year cycle depending on latitude and longitude bands. Different authors also report a moderate to strong correlation between solar activity and rainfall or the monsoon rainfall variability (Ananthakrishnan & Parthasarathy, 1984; Parthasarathy *et al.*, 1993; Jain & Tripathy, 1997; Rodrigo *et al.* 2000; Hiremath & Mandi, 2004; Hiremath, 2006).

The history of studying the possible influence of solar activity on the agricultural economics is rather long. In the past, researchers focused mostly on the influence of solar activity on wheat price (Jevons, 1884). Jevons (1884) studied the fluctuation of wheat prices over 140 years (1259-1400). He discovered a causal connection between the 11-year solar cycle and wheat price. Some more recent works (Pustilnik & Yom Din, 2004, 2009) have shown that a possible nonlinear causal connections between solar activity and wheat prices may exist, and that the influence is not homogenous, but varies with latitude (Pustilnik & Yom Din, 2009).

According to the reviewed literature, we could draw a conclusion that variability in solar activity somehow influences temperature, Earth's cloud cover and rainfall. Since salt production in traditional salt-pans is highly sensitive to weather conditions, especially summer rainfall and low temperatures, we can speculate about possible physical connection between sunspot number and salt production as well as its price during the period of the MM.

MATERIAL AND METHODS

The relevant data on salt production and its price was collected from original sources. The Piran Archive has been an important and reliable source of information regarding salt harvesting and salt price. The first record mentioning salt production is from 1637, while the recorded data can be found until 1685 with the exception of years 1657, 1658, 1663 and 1672, which were not recorded. In 1685, after the salt clerk Giorgio Giraldio finished his long career, the systematic record of these data also came to an end. During all this time, the salt workers of Piran were allowed to produce 5,200 modio per year or 26,000 modio every five years. If they did not produce the agreed quantity during a particular year, they were allowed to produce more in subsequent years to reach the agreed limit. During the period 1637 – 1646, the salt workers of Piran exceeded the agreed quantity by 3,453 modio. According to the data, they produced much less than agreed over the next three decades. Also in the decade 1730 – 1739, when they produced 42,497 modio of salt, they did not reach the allowed quantity of salt. The exceptionally bad harvests were in years 1649 (259 modio), 1650 (1,219 modio), 1652 (1,697 modio), 1675 (1,747 modio) and 1677 (1,530 modio). Not only the inclement weather conditions, but also the poor maintenance of the salt fields and protective dykes were reported as reasons for the bad harvest. On September 21st 1675, the salt workers Domenico and Bernardino Caldana asked the Salt Magistracy for a loan of 500 ducats in order to improve the salt fields. In their application they stated that salt seasons had been very poor, and that they also had low production of oil and wine. Despite overall bad decades for salt production during the MM, some exceptions were also recorded. The records of very good harvests can be found for years 1637 (10,078 modio), 1659 (10,155 modio), 1683 (10,522 modio) and 1685 (10,537 modio). In 1718 they produced as much as 12,000 modio. According to the economic policy of the Venetian Republic, the salt production was strictly regulated and the overproduction not allowed. To limit the production in good seasons, the authorities prohibited daily salt harvesting and limited the work to every second or third day and sometimes even to every fourth day. For example, at the beginning of the salt season in May 1707, the authorities issued a decision ordering the salt workers of Piran to harvest salt every third day. This measure was taken also to improve the quality of the salt. If the salt workers harvested the maximum quantity of salt allowed, they were forbidden to harvest any more from 20th August onward. If the warehouses were full and the salt workers harvested too much salt, they threw the surplus back into the sea. If the quantity of the salt produced was too small, the season was extended through September.

During the 17th and 18th century, the size of the salt-pans remained unchanged. As mentioned before, at the beginning of the MM the salt price increased twice: in 1650 by 13.7 % and in 1664 by additional 10.6 %. The final salt price of 19 lire per modio was maintained during the remaining 50 years of the MM. In 1721, immediately after a larger number of sunspots emerged, the price of salt decreased by 25.3 % to 14.2 lire. The organized data series for salt harvesting and salt price from year 1637 to year 1744 was partially published in Bonin (2001).

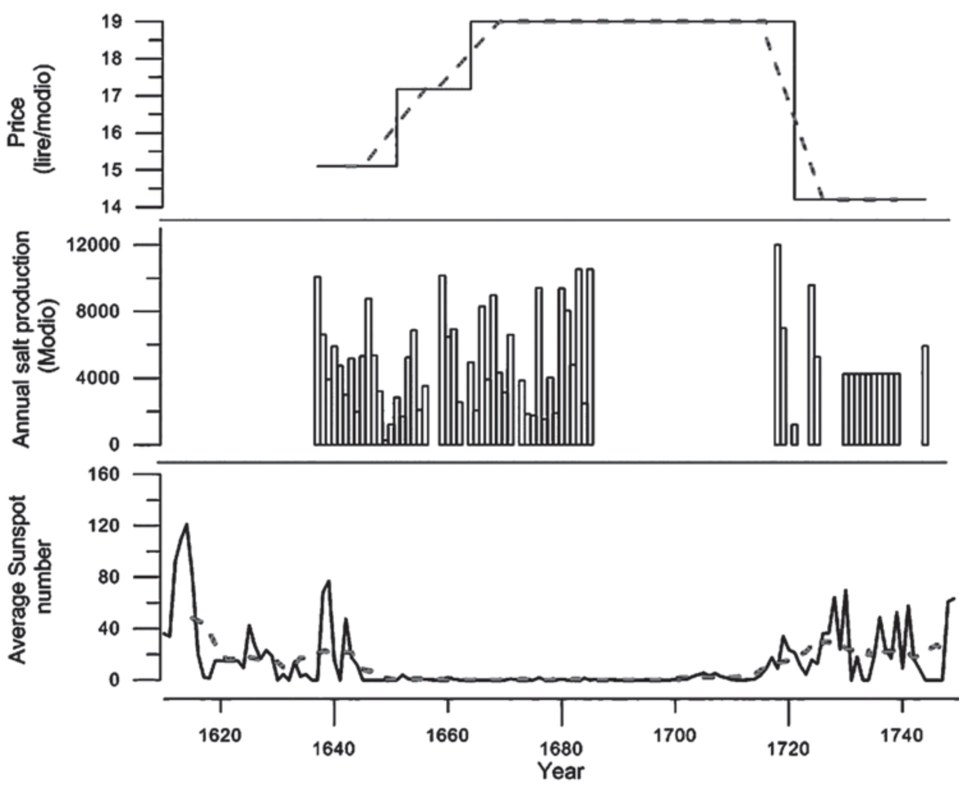

Fig. 1: Time series of salt production, salt price, and average sunspot number (dash lines represent 11-year running average smoothed data).
Sl. 1: Časovna vrsta pridelave soli, cene soli in povprečnega števila sončevih peg (črtkana črta prikazuje 11-letne drseče sredine)

Several sources of historical records have been used for historical climatic reconstruction. In collecting and organizing the historical records from different sources, substantial work was done by Ogrin (1995). In his book, he published the most complete record of climate related occurrences from the 7th to the 19th century for the Slovenia Istria, and updated previously published Braun's chronicles of weather conditions (Braun, 1934) with new historical sources. The sources contain direct or indirect information about the weather or meteorological phenomena. Most of the data he used are descriptive documentary data, in some cases describing weather consequences (flood, famine, and drought) rather than weather conditions. According to available information, he divided the weather conditions into six groups; hard winters, mild winters, drought in vegetation period, wet vegetation period, strong storms with wind and hail, years of famine and shortage. Cammuffo (1987), who researched the freezing of the Venetian Lagoon in the past, points out to the fact that during the Venetian Republic *i.e.* until 1797 the new year began after the March 1 and that this must be kept in mind when comparing Gregorian, Venetian and modern climatological dating. This, in some cases, could cause one year fictive difference between the events that occurred in the same year. Although we noticed some possible differences in dating of the same events studied in the course of this research, this problem is of secondary importance, since the data time series were smoothed for the analysis.

In order to study the correlation between sunspot number, salt production and price and different climate occurrences during the MM, the annual average sunspot number time series for the period from 1610 to 1950 was obtained from the National Geophysical Data Centre in Boulder USA (National Oceanic and Atmospheric Administration).

Visual inspection of Figure 1 shows a possible correlation between the sunspot number series and salt price series and some indices of correlation between the sunspot number series and salt production.

Different statistical tools were used to detect the relationship between different variables. For the analysis of a possible relationship between solar activity and historical events of extreme weather, the data of sunspot number and the data of extreme weather conditions were

Tab. 1: Correlation coefficients (rpb) of relationship between average sunspot number (original data and 11-year running average) and historical events of extreme weather (1610-1850).
Tab. 1: Korelacijski koeficienti (rpb) med povprečnim številom sončevih peg (izvirnimi podatki in 11-letno vrsto drsečih sredin) in pojavnostjo ekstremnih vremenskih dogodkov

Variable	rpb	Sig. (*P*)	Occurrence during MM (event/year)	Occurrence outside MM (event/ year)	Fisher exact sig. (*P*)
Hard winter	-0.087	0.874	0.11	0.15	0.541
Mild winter	-0.041	0.522	0.04	0.04	0.929
Wet vegetation period	0.092	0.148	0.06	0.02	0.093
Drought in vegetation period	0.024	0.703	0.04	0.11	0.102
Strong storms	-0.101	0.112	0.16	0.07	0.034*
Correlation coefficient for smoothed data					
Hard winter	-0.104	0.143			
Mild winter	-0.072	0.161			
Wet vegetation period	-0.136	0.008*			
Drought in vegetation period	0.072	0.163			
Strong storms	-0.192	0.000*			

*coefficients are statistically significant at 0.05 levels

used. Weather conditions reported as hard winter, mild winter, drought in vegetation period, wet vegetation period and strong storms can be considered a dichotomous variable, with value 1 if the condition occurs. Sunspot number time series is a continuous quantitative variable. To study the relationship between these two variables, the point biserial correlation seems to be the most appropriate. Fisher's exact tests were used to identify differences in the frequency of extreme weather events during the MM compared with both earlier and later period. In order to determine how low sunspot number during the MM influenced the salt production and salt price, a cross-correlation analysis was applied.

The data series of salt production were incomplete, covering only the years from 1637 to 1685 and from 1718 to 1744 with some gaps. One of the main problems is the 33-year gap from 1686 to 1717. After the year 1680, the data is less accurate and the gaps in records are more frequent. For the period from 1730 to 1740 the records are available only as a sum of five years production. In Figure 1 the data for this period are presented as five yearly averages. Since the data for the second period is less accurate, only the first part of data series was used in the analysis. However, no data have been found for years 1657, 1658, 1663 and 1673. Instead, the mean values for the series were used.

RESULTS AND DISCUSSION

The overlapping period 1610-1850 of two time series, average sunspot number and extreme weather condition occurrence were used to investigate the influence of the MM on the Slovenian Istria climate. Additionally, to assess the influence of the MM on the frequency of a single group of extreme weather events, Fisher exact test was applied. Results of point biserial correlative analysis and Fisher exact test are presented in Table 1.

From the second and the third column it is evident that no significant correlation between observed variables exists. Relating the number of sunspots with climate/weather, it has been established (Reid, 1991; Waple, 1999; Hiremath & Mandi, 2004; Hiremath, 2006) that changes in climate are associated with the 11- year solar cycle. As suggested by previous studies (Lebitzke & Van Loon, 1988; Bottomley *et al.*, 1990; Tsiropoula, 2003), the sunspot number data were smoothed with 11-year running average and new values of correlation coefficients for sunspot number smoothed curve were calculated. This method also gained poor correlation (rpb < 0.19). However, the results suggest a possible negative correlation with wet vegetation period (rpb = -0.136; *P* = 0.008) and strong storms (rpb = -0.192; *P* = 0.000). The proposed significant correlation for strong storms and wet vegetation period is in good accordance with the findings of other studies, in which authors reported on the association between reduced solar activity and increased storminess (Björk & Clemmensen, 2004; Van der Schrier & Barkmeijer, 2005; Clarke & Rendell, 2009), and increased rain/snow precipitation (Svensmark & Friis-Christensen, 1997; Marsh & Svensmark, 2000; Kniveton & Todd, 2001). As seen in Figure 2, records of wet vegetation period are distributed only dur-

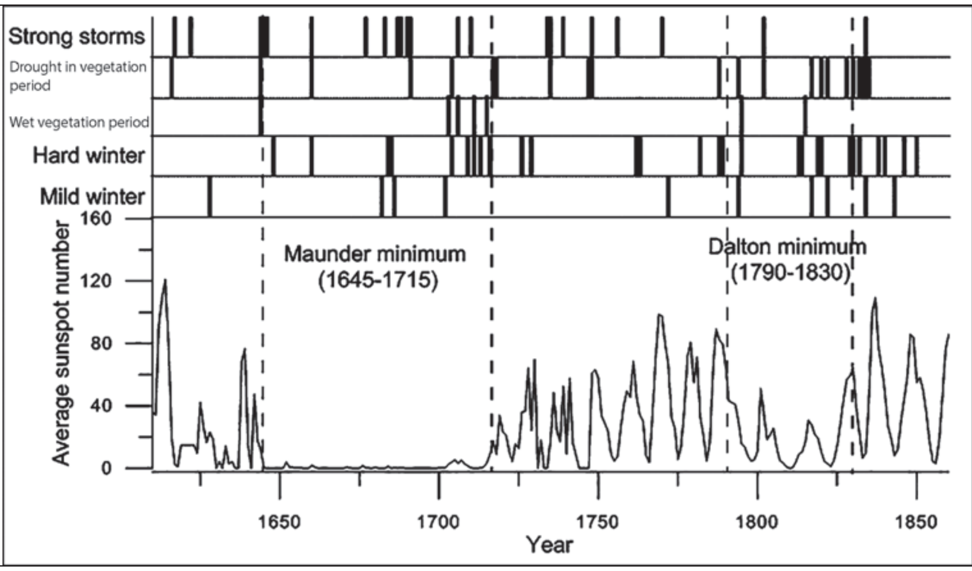

Fig. 2: Extreme weather events in the Slovenian Istria from 1600-1850.
Sl. 2: Prikaz ekstremnih vremenskih pojavov v slovenski Istri od leta 1600 do 1850

ing the two periods of reduced solar activity (Maunder and Dalton minima).

The last column in Table 1 shows the significance of Fisher exact tests. The results confirm higher frequency of strong storms with hail and strong wind during the MM compared with both earlier and later period (P = 0.034). Given the validity of the correlation between average sunspot number and some extreme weather events, the correlation between salt production and extreme weather events was also investigated. The results suggest a statistically weak positive correlation between strong storms and salt production (rpb = 0.255, P = 0.046).

According to the findings in the reviewed literature, we expected a significant negative correlation between average sunspot number and hard winter occurrences. However, the results in both models show no relationship (rpb < |0.104|, P > 0.143). As it is clearly evident from Figure 2, hard winters frequently occurred over the whole time period from 1650 to1850 regardless of the single solar cycle. The reason for poor correlation might be the fact that we analysed only a time segment in the period of the so called Little Ice Age (variously assessed as AD 1430-1850), while longer time series extended over the Little Ice Age may be required to confirm the proposed relationship between variables.

The purpose of this study was also to identify the possible influence of the MM on salt production and its price. For this purpose, data series of salt production from 1637 to 1687 and data series of salt price from 1937 to 1744 were cross-correlated with average sunspot number. For the salt production data series, the largest correlation coefficient (r = 0.316) was found at lag of -10 years. A larger correlation coefficient was obtained by using 11-year running average (r = 0.571) with lag of 6 years. In order to understand how the lag varies in time, a cross-correlation was calculated for every solar cycle before 1645 and the period after. In the first three cycles the lag has a decreasing trend, with correlation coefficients up to r = 0.80, afterwards the lag changes from positive to negative. It seems that the lag between average sunspot number and salt production varies in time with no understandable pattern. In other words, since the salt production was not limited only by weather but mostly by political decisions, the salt production time series contains "social noise" that is difficult to quantify, and strongly influences the results. The production of salt was strictly regulated with the salt contracts and limited to yearly production of 5,200 or 2,600 modio in total for the five-year period. In good seasons the authorities prohibited daily salt harvesting and even ordered the harvested salt to be thrown back into the sea when the warehouses were full. With strict regulation and control of salt production in good seasons, the authorities had much more influence on harvested quantity than the weather conditions.

As evident from Figure 1, there is almost no variability after year 1640 in sunspot number series, resulting in the largest discrepancy between the two series. Assuming that both, the lack of variability in average sunspot number during the MM, as well as "social noise" in salt production series are the causes of poor results, an extended time series over the end of the MM would be needed to completely understand the nature of the relationship. To gain complete understanding of how good individual harvest seasons were, additional information *i.e.* the end of the season in a particular year, or the limitations of work in the salt-pans, would be needed to distinguish between good and excellent seasons. The fact that climate variations during the MM could in a certain year lead to favourable weather conditions for salt production (as in 1659, 1983, 1985) must also be considered since the salt production is less sensitive to annual totals or averages of different parameters (precipitation, irradiation, temperature) than to the distribution of this parameters in form of weather anomalies during the harvest season. Apart from this, one must not forget that the production of salt was arduous, labour intensive and time consuming process in which also poor maintenance of the salt fields and protective dykes could be the reasons for bad harvest. Thus, the question of the influence of low solar activity on the salt production in the Sečovlje salt-pans remains unanswered.

Furthermore, a cross-correlation between average sunspot number and salt price data series showed a moderate negative relationship ($r = -0.518$, $P = 0.000$). Even largest correlations coefficient exits between 11-year running average sunspot number series and 11-year running average salt price series ($r = -0.848$, $P = 0.00$). Since there is no statistical evidence of relationship between salt production and salt price ($r < 0.103$, $P > 0.482$), the influence of solar activity on salt price cannot be explained through the chain of linear connections: solar activity-terrestrial climate-salt production-salt price. It is possible that the link among sunspot numbers, salt production and price are not always linear, and relatively small variation in salt production can cause a sharp change in prices (similar to wheat prices - described in depth by Pustilnik & Yom Din, 2004). In a relatively isolated and monopolized salt market, the variability in weather conditions or low number of sunspots during the MM may lead to a precaution of the Salt Magistracy in salt price forming policy.

CONCLUSION

Although the influence of solar activity/weather on the salt production in open salt-pans is evident, our results failed to confirm a significant relationship between sunspot number and salt production. There are several reasons that could explain the lack of correlation, perhaps the two most important being the strictly regulated and limited salt production (mostly to keep the high salt price) and the absence of a common time interval extend to reliable sunspot observation data. The low variability in sunspot number observation data and salt price data causes a lot of problems in the analysis, as well. Another concern is the used methodology. The missing data in time series constrain us to smooth the series with 11-years running average, what may cause spurious results and findings should be interpreted with caution. Thus, the question of how if at all the climate during the MM influenced the salt production remains unanswered.

By analysing the frequency of extreme weather events during the period from 1610-1850 and the solar activity, overall conclusions are as follows:

1. The results suggest a possible negative correlation with wet vegetation period ($rpb = -0.136$, $P = 0.008$) and strong storms ($rpb = -0.192$, $P = 0.000$).
2. During the MM, strong storms with hale and strong wind were statistically more frequent compared to both earlier and later period ($P = 0.034$).
3. Opposite to our expectations, the results in both models show no relationship ($rpb < |0.143|$, $P > 0.143$) between hard winters and average sunspot number.
4. The weak correlation established between extreme weather conditions and solar activity may indicate that the MM influenced the climate in the Slovenian Istria.

Additionally, the results imply a causal connection between solar activity and salt price series ($r = -0.848$, $P = 0.00$). However, since the salt price changed only three times during the MM, these results are inconsistent and spurious due to lack of variability in the dataset. There are some other parameters that might influence the salt price, and caution should be taken in interpreting the results.

Despite our efforts, many questions remain unanswered. Additional data sets and much further investigation would be needed in order to understand how if at all, the MM influenced the salt production in the Slovenian Istria. The possibility of using other proxy of solar activity as ^{10}Be isotopes from Greenland ice (Beer *et al.*, 1998), and extended time series of salt production data could give us another chance of finding the answer to our question.

POSKUS PRIKAZA VPLIVA PODNEBJA IZ OBDOBJA MAUNDERJEVEGA MINIMUMA NA PROIZVODNJO SOLI IN NJENO CENO V SLOVENSKI ISTRI (SEČOVELJSKE SOLINE)

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POVZETEK

V članku obravnavamo žetev morske soli v Sečoveljskih solinah v letih 1637–1744, ki so tedaj spadale pod Beneško republiko. Obdobje 1645–1715 sovpada s t. i. Maunderjevim minimumom, ko so opazovalci ugotovili minimalno sončevo aktivnost. Kot kazalnik sončeve aktivnosti smo uporabili število sončevih peg. Pregledali smo različne historične klimatske podatke in predstavili rezultate empirične analize možne povezave med sončevo aktivnostjo v obdobju Maunderjevega minimuma in proizvodnjo soli kot tudi njeno ceno. Rezultati sicer kažejo na vzročno povezavo med sončevo aktivnostjo in ceno soli, a nas je težava z nezanesljivimi in kratkimi časovnimi vrstami ter manjkajočimi podatki prisilila v uporabo statističnih metod, ki lahko privedejo do nekonsistentnih in zavajajočih rezultatov. Na podlagi rezultatov analize zato ni možno potrditi povezanosti med pridelavo soli, ceno in sončevo aktivnostjo.

Ključne besede: Maunderjev minimum, število sončevih peg, sončeva aktivnost, podnebje v predinstrumentalnem obdobju, proizvodnja soli, Sečoveljske soline.

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