International Journal for Quality Research 11(3) 717–728
ISSN 1800-6450

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SUNSPOT CYCLES IMPACTS ON TOURISM AND QUALITY OF LIFE

Article info:
Received 06.03.2017
Accepted 12.07.2017

UDC – 91
DOI – 10.18421/IJQR11.03-14

Abstract: *We live under the influence of natural cycles caused by the rotation of our planet and its revolution around the sun. The nature of our nearest star is also subject to cyclical change. This article presents a study of a correlation between sunspot cycles and foreign tourists arrivals in Slovenia, based on historical data between sunspot cycles and sea salt production in Slovenia's Municipality of Piran during the Maunder Minimum period (1645–1715). The production of salt by the solar evaporation of brine in salt pans and tourist industry are seasonal economic activities that are affected by changes to the weather. The paper looks at sea salt production in Piran during a particular period in the past. The repetition of the sea salt production in the past is not possible. For this reason, the study uses mathematical tools and an additional case study, which analyses arrivals of foreign tourists to Slovenia over the past 65 years (1948–2012). The study has two purposes: to identify a linear correlation coefficient, which provides evidence of a correlation between arrivals of foreign tourists to Slovenia and sunspot cycles and to develop a causal loop diagram (CLD) or so called qualitative model of a complex tourism system, which shows the interdependency of sunspot cycles, tourism system, and quality of life.*

Keywords: *sunspot cycles, Maunder minimum, foreign tourist arrivals, CLD modelling, quality of life*

1. Introduction

The theoretical assumptions underlying this study stem from the results of data, operating in a reverse fashion when compared with traditional research. Our assumptions, based on these data, used inductive reasoning (Cassell & Symon, 2004; Heath & Cowley, 2004). With inductive reasoning, the theory should more or less match the data, be relevant to it and it should be possible to work with and modify the theory according to new data or newly organised data sets. As with all scientific research, any theoretical assumptions derived from data should be provable and repeatable (Kennett, 2014). From the outset, such assumptions should be internally consistent, coherent and without error. In the process of building a theory, additional research on similar examples helps in the formulation and validation of the theory, and in the identification of any contradictions that might otherwise lead to unrealistic results. Such a treatment enables mathematical modelling and the use of scientific methods. It is a form of

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epistemology, which is the theory of knowledge (Moglia et al., 2011; Hoda et al., 2012).

The research described in this article bases on data from various archives. As the phenomena occured in the past, they are unique, and any repetition is impossible. We extracted periodic events from these phenomena, which occurred in twelve-year cycles. From these results, we established a theory that seasonal economic activities, which are influenced by changes in the weather, are also affected by sunspot cycles. The basic research idea arouses from the curiosity and the wish for greater understanding. We anticipate that the results of the research will provide useful knowledge on how to make long-term predictions for seasonal economic activities. These long-term predictions are more convenient for managing processes and their regulation than providing a complete analysis of all the factors that contribute to the success of these economic activities (Adolpha et al., 2012; Dunne, 2011). The most important processes comprise key decisions at the highest level of management together with staff education and experience.

2. Sunspots

The existence of spots on the sun and their variation knew the scholars in the antique time. Sunspots had been observed and described more than two thousand years before the invention of the telescope. Their appearance correlated with changes in the weather (Galilei & Scheiner, 2010). The introduction of the telescope to astronomy at the beginning of the seventeenth century changed astronomical observations forever and also accelerated the development of optics and epistemology. The telescope was used to observe and describe the heavenly bodies, the moon, the sun and its sunspots.

The discovery of sunspot cycles at the beginning of the nineteenth century was one of the most important discoveries in astronomy (Arlt, 2011). All our knowledge about the nature of the sun, which directly affects the earth and life on it, is a result of that discovery. From a combination of sunspot numbers and their distribution on the solar disc in the past 150 years, it follows that the maximum number of solar activities repeated between every 9.5 and 11 years. Wolf's number is another name for this repeating period (Clette, 2007). These cycles take too long to impinge directly on our everyday life. As a result, we either fail to notice their influence or simply forget it. The identification of the nature of sunspots started at the beginning of the twentieth century. They appear because of an anomaly in the sun's magnetic field (Hale et al., 1919). Later on Milanković published his calculations on the temperature at different points on the surface of Earth at different times of year from axioms, or first principles in Théorie mathématique des phénomènes thermiques produits par la radiation solaire (Mathematical Theory of Thermal Phenomena Caused by Solar Radiation). The calculations gave results that were roughly in line with empirical data concerning early 20th-century temperatures, and they immediately attracted the attention of meteorologists. Together with astronomer Köppen and geophysicist Wegener, Milanković presented the effect of known regular changes in three astronomical parameters: the obliquity (tilt) of Earth's axis of rotation, the precession (wobblelike movement) of the rotation axis, and the eccentricity (a measure of the elliptical shape) of Earth's orbit around the Sun. Those three parameters govern the amount of solar radiation (insolation) that strikes Earth's surface at different latitudes in different seasons. Because they operate on different timescales, the parameters affect climate by interacting in a manner that sometimes increases and sometimes decreases the insolation at a particular location (Macdougal 2014, Milanković, 1941).

At the time of the Maunder Minimum, the observation of the sun was 68% (± 7%) of available days (Hoyt & Schatten, 1996). During that period appeared the sunspots notification and the observation of few polar lights, which reinforces the existence of the Maunder Minimum. Radioactive isotopes produced by cosmic rays in the upper layers of the atmosphere are a confirmation of its existence in the past. Deposits of cosmogenic carbon-14 and beryllium-10 were particles in the remains of living bodies and in Antarctic ice (Beer, 2000).

In this article, we used yearly sunspot numbers from two different sources: the estimated numbers for the period from 1610 to 1700 (National Geophysical Data Center (NOAA), 2007) and the average numbers of sunspots since the year 1700 (SILSO, 2014). These verified and systematically arranged data sets were used to calculate a linear correlation coefficient with data sets from two local commercial activities that are seasonally affected: sea salt production in Piran during the time of the Maunder Minimum and arrivals of foreign tourists to Slovenia between 1948 and 2012.

3. Historical data - maunder minimum in Piran

Studies about possible connections between space weather and storms in earth markets numbers are more than 300 years old (Jonathan Swift, 1726, William Hershel, 1801, William Jevons, 1878) The Republic of Venice (*Serenissima Repubblica di Venezia*) lasted from the 7th century until 1797. Initially, fishing and salt production were the main sectors of its economy. The development of the shipping trade led indirectly to the development of other activities. A typical characteristic of Venetian economic policy was the unacceptability of a market surplus for any type of goods. State monopolies were carefully maintained to ensure steady prices. The state prohibited the import of goods or their production to prevent any reductions in price (Bonin, 2005).

In the thirteenth century, the Senate of the Venetian Republic appointed a large number of magistrates, which restricted the authority of the Doge. An administrative body for salt was also established (*Magistrato sopra i sali*). This body had four overseers, political appointees held by noblemen for two years and later 18 months. They issued salt contracts for the production and trading of salt for every salt field in the territory of the Republic. These contracts ensured a state monopoly over salt in the domain of the Adriatic Sea. Despite the administrative restrictions, significant levels of salt smuggling happened. The overseers received reports on smuggling, which increased, especially in those periods when the price of salt was high (Bonin, 2005). Salt was one of the most important additions to food since people used it for food preservation.

The city of Piran, which now lies in Slovenian Istria, was part of the Venetian Republic from the end of the thirteenth century until its decline. The first known salt contract between the Venetian Republic and the Municipality of Piran dates from 1375 (Bonin, 2001). Venetian government, represented by the administrative body for salt, and the Municipality of Piran, represented by the Council of Twenty for Salt (*Colleggio dei XX del sal*) signed salt contracts. The Council consisted of twenty representatives of salt field owners in Piran. At first, these contracts were valid for five years. At the beginning of the eighteenth century, however, this period was extended to twelve and later increased to fifteen years. The last salt contract between the Venetian Republic and Piran, dating from 1780, was made for 20 years. The main part of these contracts was the price of salt. In a salt contract set up in 1636, the yearly limit of sea salt to be produced in Piran was 5200 *modi* (a *modio* is equivalent to 801 kg). This quantity remained stable for a further 113 years. During this entire period, the amount of salt produced in Piran changed very little. A study on possible causal connections between solar activity and wheat prices. (Pustilnik & Yom Din, 2004), was shown that a complex causal chain can have taken place.

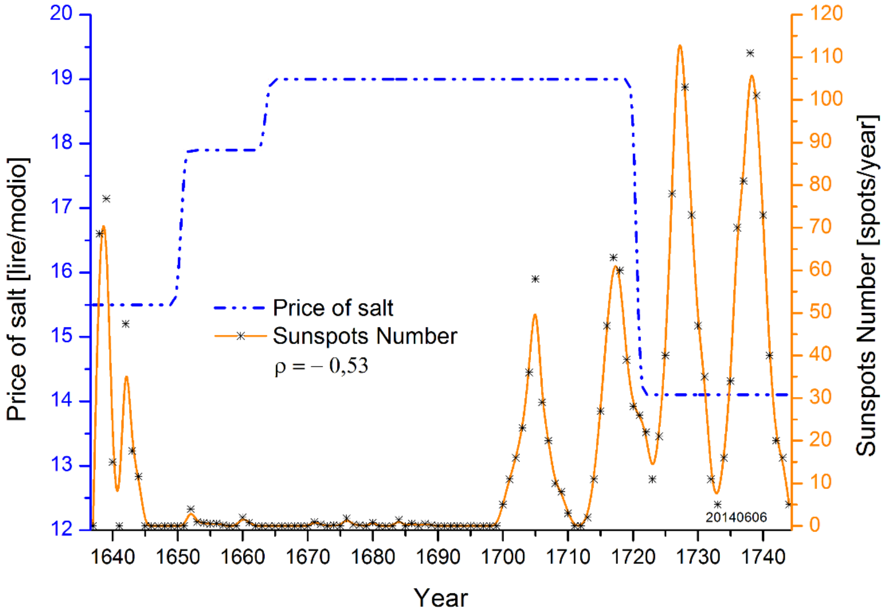

Figure 1. Correlation between the price of sea salt in the Republic of Venice and the number of sunspots during the Maunder Minimum

The Piran Archives include data relating to the quantities of salt harvested in Piran (Bonin, 2001; Bonin & Čop, 2008). The earliest data about salt production are from 1637. The data were regularly recorded until 1685 when their systematic registration stopped. During this entire period of 48 years, only the data for 1657, 1658, 1663 and 1672 are not available. For the following 70 years, until 1744, there are data for five separate years and a further two 5-year periods (1730–1734 (21,170 modi) and 1735–1739 (21,327 modi)).

In Piran, salt contracts determined the price of salt per modio in *lire* (*1 lira veneziana* = 1/2 *ducato d'oro* = 20 *soldi* = 240 *denari*) from 1637 until 1744 (Figure 1). The linear coefficient of correlation between (Stigler, 1989; Rodgers & Nicewander, 1988) the price of salt and the average number of sunspots in the observed period is ρ = - 0.53. The anti-correlation between these two groups of data means that the price of salt went up when the number of sunspots was lower.

4. Foreign tourists arrivals between 1948 – 2012

In the past 65 years, annual data relating to the arrivals of foreign tourists have been taken from different sources and then arranged by year (Zavod Republike Slovenije za Statistiko [Slovenian Department of Statistics], 1971, 1992; 2013). Slovenian Department of Statistics recorded extreme events in the data for the period between 1948 and 2012.

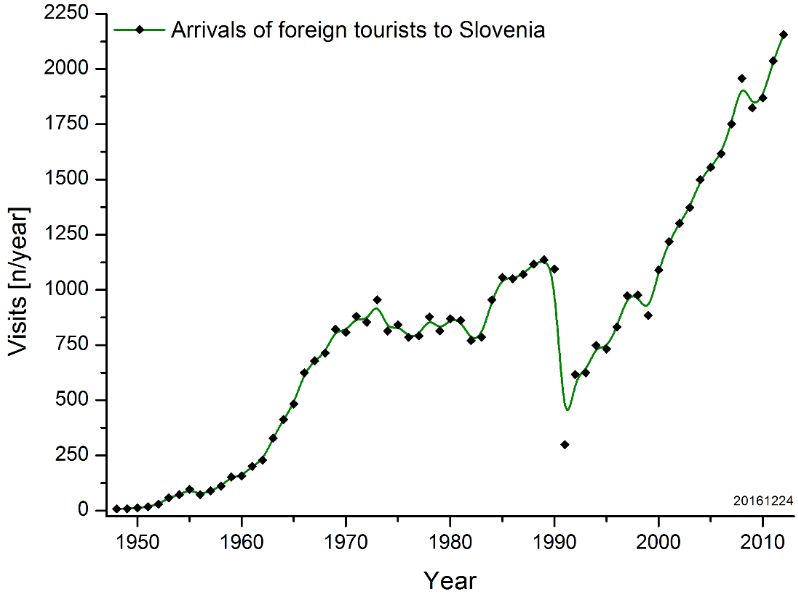

Figure 2. Arrivals of foreign tourists to Slovenia from 1948 to 2012

In 1973, a steady increase in the number of tourists stopped abruptly and, in 1991, there was a dramatic decrease in the number of foreign tourists (Figure 2). These events derived from the political situation in Slovenia at the time, namely, the result of political instability in 1973 and the breakup of Yugoslavia in 1991. The time distance between these two events is 16 ± one year. Throughout the entire observed period of 65 years, there were shorter periods of change with lower amplitudes, with periods of three to five years and from six to eight years. The shortest periods of decrease occurred in 1999 and 2009. The data relating to arrivals of foreign tourists are not as reliable statistically as data relating to overnight stays. The political events at that time influenced the data relating to overnight stays. A linear correlation coefficient between the annual numbers of foreign tourists and annual sunspot numbers in the past seven sun cycles is ρ = - 0.30 (anti-correlation). As for the numbers of these cycles in the past 65 years, there is a very probable correlation in anti-phase.

A detailed analysis of the graph in Figure 3 shows that during the most rapid increase of sunspot numbers, the number of arrivals of foreign tourists decreased, and vice versa. These roughly seven-year cycles had a lower amplitude between 1948 and 1973 when arrivals of foreign tourists increased steadily.

We carried out an FFT frequency analysis (Cooly & Tukey, 1965; Bergland, 1969) of the available data for the annual numbers of arrivals of foreign tourist for the period between 1948 and 2012.

The cyclical events at the 10.83 and 13-year period points have nearly the same level of power and coincide with well-known natural cycles, namely, sunspot and geomagnetic storm cycles (Cliver, 1994). Each has greater power than the 16.25 year period point, caused by the political events in Slovenia at the time (Figure 4). The 10.84-year period point is little higher than the average value of 10.78 year periods for the sunspot cycles numbered 19 to 23. Sunspot cycle 19 started in April 1954, and sunspot cycle number 23 ended in January 2008 (SILSO, 2014; Hathaway, 2015).

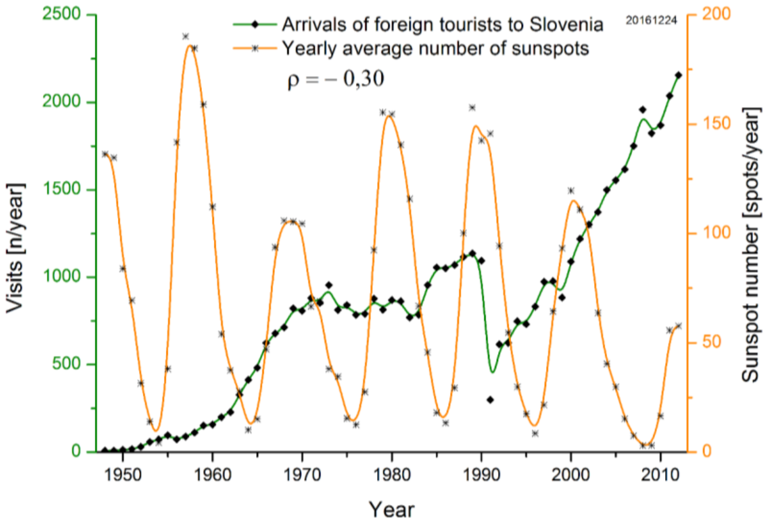

Figure 3. Correlation between the annual numbers of arrivals of foreign tourists to Slovenia and sunspot numbers from the eighteenth to the twenty-fourth sunspot cycle

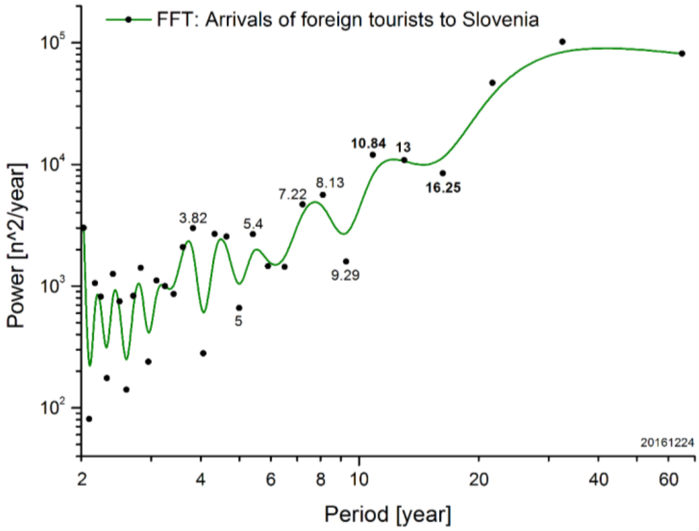

Figure 4. Results of frequency analysis (FFT) of annual arrivals of foreign tourists' data in Slovenia from 1948 to 2012

5. Results and CLD model

Comparison of the available data of sea salt production in the Piran Municipality during the time of Maunder Minimum with the estimated data of sunspot numbers during the same time did not give the expected results (Bonin, Čop, 2008). The raised price of salt at the time in Venetian Republic shows a great shortage of this commodity on the market at that time.

The linear correlation between the salt production in the Piran Municipality and the sunspot numbers during the time of Maunder

Minimum does not exist. Also, other types of correlations did not give any useful results (Paliska et al., 2015) mainly for the lack of continuous data. Behind the deficiency of adequate data, the same question crops up as it appears to the collector of data of production: Are the data of salt production in the Piran Municipality at the time of Maunder Minimum correct? Between 1994 and 1997 the salt production was organized in the Piran salt pans of the same dimensions as those during the seventeenth century. The harvest of sea salt was from 3.1 modi per salt pan in the rainy year to 6.2 modi per salt pan in the year with good weather conditions. However, during the time of Maunder Minimum, this production was limited by a Salt Contract to 2 modi per salt pan (Bonin, 2001).

To obtain the expected results and to check the data sets more easily we used the data relating to the arrival of foreign tourists in Slovenia for the past sixty-five years (1948-2012) for additional verification of linear correlation with annual sunspot numbers. The result of this mathematical operation is a linear anti-correlation coefficient $\rho = -0.30$.

In parallel measurements with the same type of magnetometers, but with different serial numbers, in two neighboring observatories on four successive geomagnetic very calm days, the reckoning linear correlation coefficients are ranging from $\rho = 0.81$ to $\rho = 0.93$ with the average value of $\rho = 0.85$ (Čop et al., 2011). The value of this correlation significantly drops if the observatories are on different geographic latitudes and longitudes, and they can also reach negative values. These measurements have something in common; they represent the flux of energy from the Sun to the Earth's magnetosphere. Following the results of the research and the newest data of spectral analysis, we will build a diagram – a model, which will serve as a describer of the activity of basic mutual influences among variables. We will use systems methodology, which is due to its transparency an excellent tool for modelling of complex systems. Causal-loop (CLD) model is a mental model, which is the basis of causal connections among model variables: sunspot cycles, tourists' arrivals, investments to tourism, tourism market, science & research, and quality of life. We present it in figure 5. Model is only a graphic presentation of a real system, which consists of elements and is greater than its parts. If we connect the set of system's elements on the basis of their descriptions, with arrows pointing in the same direction, and denote them with the symbol (+) opposite the symbol (-), we create an influential diagram. We build a causal loop diagram where we label a link polarity by adding '+' or a '–' sign at each arrowhead to convey more information. A '+' is used if the cause increase, the effect increases and if the cause decrease, the effect decreases. A '-' is used if the cause increases, the effect decreases and if the cause decreases, the effect increases (Jere Jakulin, 2017). Building causal-loop diagram has a strategic meaning. It shows correlations among parameters, which are important when we want to show how the system in reality works and what could be a strategy for its development in the future. It is a good presentation for decision-makers, who become aware of correlations among parameters of a model in our case aware of the power of sunspot cycles. Thus, they can develop a strategy and anticipate time for the investments. The behavior of the model in figure 5 is as follows: sunspot cycles increase tourists' arrivals (+), which positively influence the investments (+), increase mass tourism (+) and decrease (-) attractiveness of the area. Area attractiveness increases (+) tourism market, which increases (+) science and research activities. These influences (+) area attractiveness, which gives positive feedback (+) to science and research and quality of life. Quality of life positively affects (+) science and research and this increases (+) knowledge about solar activities- sunspot cycles.

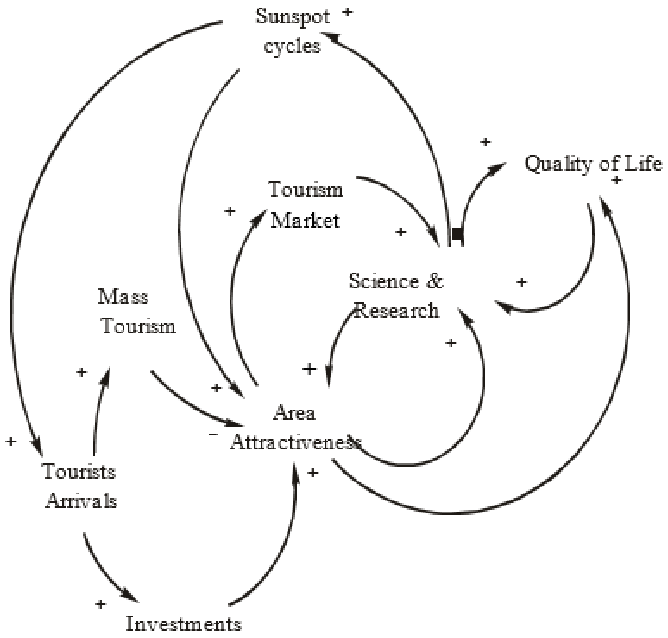

Figure 5. Causal loop diagram (CLD) of interdependency between sunspot cycles, tourists' arrivals investments, area attractiveness, and quality of life

Above described interdependency among elements of a complex tourism system presents system dynamics as a methodology for solving complex systems problems. According to Sterman (Sterman, 2000), system dynamics is:

A. Methodology for understanding complex problems where there is dynamic behaviour (quantities changing over time) and where feedback impacts significantly on system behaviour.
B. Framework and rules for qualitative description, exploration and analysis of systems regarding their processes, information, boundaries and strategies, facilitating quantitative simulation modelling and analysis for the design of system structure and control.
C. Rigorous study of organisational problems, from a holistic or system perspective, using the principles of feedback, dynamics and simulation (Jere Jakulin, Kljajić, 2006).

5. Conclusions

After the frequency analysis during the sixty-five-year period, we see that the power of influence of solar cycles on the tourist industry in Slovenia is comparable with the power of political events. This industry is in major part a long-term investment, especially in hotels. For a long-term planning of this industry, it would also be very useful to study the influence of solar cycles on it. Therefore, it would also be necessary to use adequate data sets from other tourism-orientated countries. Moreover, the standard verification of economic efficiency of the tourist industry in those countries would help in decision-making to take seriously into concern the influence of sunspot cycles upon tourist arrivals and consequently to rethink investments to tourism.

There is not only the cycle of sunspot numbers which the Sun creates. In the time of its minimum, the circumstances in the space around the Earth are not calm; they are only changed (Eddy, 2009). In that time the flux of cosmic rays are bigger which influence the formation of the clouds (Svensmark, 2000, National Academies, 2011). The Sun with its activity also directly influence on the health of the people (Palmer et al., 2006) and the nowadays technology (Čop, 2015). All these phenomena change our way of life and also change the direction and intensity of tourist's currents flow. To present this practically, we used a systems methodology. System dynamics enhances learning in complex systems, which features are in a quantity of parameters tightly interconnected and interdependent: such as tourism, economy, industry, science, Sun. It is a method for developing management flight simulators, often computer simulation models, to help us learn about dynamic complexity, understand the sources of policy resistance, and design more effective policies. With a causal-loop diagram, which we build in a frame of system dynamics, we presented correlations among elements described in this study and the elements that are important when we research tourism and quality of life. From this diagram, one can derive the dynamic equations that are necessary for a computer simulation. We showed the equivalence of different methodologies, whose differences or similarities can be judged only in context of a problem and the aims of researches.

References:

Adolpha, S., Kruchtena, P., & Hallb, W. (2012). Reconciling perspectives: A grounded theory of how people manage the process of software development. *The Journal of Systems and Software, 85*, 1269-1286.

Arlt, R. (2011). The sunspot observations by Samuel Heinrich Schwabe. *Astron. Nachrichten, 30*(20), 1-10.

Beer, J. (2000). Polar Ice as an Archive for Solar Cycles and Terrestrial Climate. In A. Wilson (Ed.), *The Solar Cycles and Terrestrial Climate, Solar and space weather*. ESA Special Publication, *463*, 671-676

Bergland, G. D. (1969). A guided tour of the Fast Fourier Transform. *IEEE Spectrum, 6*, 41-52.

Bonin, F. (2005). *Vloga beneških funkcionarjev v primorskih mestih v 16. in 17. stoletju [The role of Venetian Republic officials in littoral cities in the 16th and 17th centuries]*. Magistrsko delo. Mentor red. prof. dr. Vasko Simoniti, somentorica red. prof. dr. Darja Mihelič. Ljubljana; Univerza v Ljubljani, Filozofska fakulteta, Oddelek za zgodovino, p. 49 [In Slovenian].

Bonin, F. (2001). Proizvodnja soli v Piranskih solinah od 16. do druge polovice 18. stoletja [Production of salt in the Piran salt pans from the 16th to the second half of the 18th century]. *Annals (Koper) Ser. Hist. Sociol., 11*, 93-104. [In Slovenian].

Bonin, F., & Čop, R. (2008). Pridelki soli v piranski komuni v času Maunderjevega minimuma [Sea salt production in the Municipality of Piran during the time of Maunder Minimum]. *Raziskave s področja geodezije in geofizike 2007*. Zbornik predavanj. Urednik Miran Kuhar. 13. strokovno srečanje Slovenskega združenja za geodezijo in geofiziko. Ljubljana: Fakulteta za gradbeništvo in geodezijo, 63-70. [In Slovenian]

Cassell, C., & Symon, G. (Eds.). (2004). *Essential Guide to Qualitative Methods in Organizational Research*. London: Sage.

Clette, F., Berghmans, D., Vanlommel, P., Van der Linden, R. A., Koeckelenbergh, A., & Wauters, L. (2007). From the Wolf number to the International Sunspot Index: 25 years of SIDC. *Advances in Space Research, 40*, 919-928.

Cliver, W. E. (1994). Solar Activity and Geomagnetic Storms: The First 40 Years. *EOS, Transactions, 75*(49), 569, 574-575.

Cooly, W. J., & Tukey, W. J. (1965). An Algorithm for the Machine Calculation of Complex Fourier Series. *Mathematics of Computation, 19*(90), 297-301.

Čop, R. (2015). Zemeljsko magnetno polje in njegov vpliv na telekomunikacije. *Zbornik referetov*. Uredil Tomi Mlinar. Brdo pri Kranju, Slovenija: 31. delavnica o telekomunikacijah VITEL, 11. in 12. maja 2015. Ljubljana: Slovensko društvo za elektronske komunikacije; Elektrotehniška zveza Slovenije, 29-33.

Čop, R., Deželjin, D., Mihajlović, J. S., & Kosovac, P. (2011). Preliminary Measurements of Geomagnetic Field Variations in Slovenia. *Elektrotehniški vestnik, 78*(3), 96-101.

Dunne, C. (2011). The place of the literature review in grounded theory research. *International Journal of Social Research Methodology, 14*(2), 111-124.

Eddy, A. J. (2009). *The Sun, the Earth, and Near-Earth Space. A Guide to the Sun-Earth system.* NASA Living with a Star grant number NNG06EC631. NASA Publication #NP-2009-1-066-GSFC. Washington (DC, US): U.S. Government Printing Office, 2009.

Galilei, G. & Scheiner, C. (2010). *On Sunspots.* Translated and introduced by Eileen Reeves, Albert Van Helden. Chicago; London: University of Chicago.

Hale, G. E., Ellerman, F., Nicholson, S. B., & Joy, A. H. (1919). The magnetic polarity of sun-spots. *Astrophysical Journal, 49*, 153-178.

Hathaway, H. D. (2015). *The Solar Cycle*. California, US: Moffett Field: NASA Ames Research Center.

Heath, H. & Cowley, S. (2004). Developing a grounded theory approach: a comparison of Glaser and Strauss. *International Journal of Nursing Studies, 41*, 141-150.

Herschel, W. (1801). *Philosophical Transactions, 91*(265).

Hoda, R., Noble, J., & Marshall, S. (2012). Developing a grounded theory to explain the practices of self-organizing Agile teams. *Empirical Software Engineering, 17*(6), 609-639.

Hoyt, V. D. & Schatten, H. K. (1996). How Well Was the Sun Observed During the Maunder Minimum? *Solar Physics, 165*, 181-192.

Jere Jakulin, T., Kljajić, M., (2006). Systems approach to complex systems modelling with special regards to tourism. *Kybernetes, 35*(7/8), 1048-1058.

Jere Jakulin, T. (2017). Systems approach as a creative driving force for a tourism destination. in: A. Királ'ová, (Ed.). *Driving tourism through creative destinations and activities, (Advances in hospitality, tourism, and the services industry).* Hershey: IGI Global, 1-19.

Jevons, W. S. (1878) Comercial Crises and Sun-spots. *Nature* XIX. 33-37.

Kennett, B. (2014). *Planning and Managing Scientific Research. A guide for the beginning researcher.* Canberra (Australia): Australian National University.

Macdougal, D. (2014) *Milutin Milankovitch*. Encyclopaedia Britannica: Encyclopaedia Britannica, inc. Retrieved on 23rd July 2017 https://www.britannica.com/biography/Milutin-Milankovitch

Milanković, M. (1941). *Kanon der Erdbestrahlung und seine Anwendung auf das Eiszeitenproblem.* Belgrade: Mihaila Ćurčića.

Retrieved on July 23 from: http://digitalna.nb.rs/wb/NBS/Knjige/Zbirka_knjiga_Milutina_Milankovica/II-016015-133?search_query=Kanon%20der%20Erdbestrahlung

Moglia, M., Alexander, K., & Perez, P. (2011). Reflections on case studies, modeling and theory building. In F. Chan, D. Marinova and R. Anderssen (Eds.). *MODSIM2011, Nineteenth International Congress on Modelling and Simulation*, 2894-2900. Australia: Modeling and Simulation Society of Australia and New Zealand.

National Academies (2012). *The Effects of Solar Variability on Earth's Climate*. A Workshop Report. National Research Council; Division on Engineering and Physical Sciences; Committee on the Effects of Solar Variability on Earth's Climate Space Studies Board, 8-9 September 2011. Washington (DC, US): The National Academies.

National Geophysical Data Center NOAA (2007). *Sunspot Numbers.* Estimated annual mean sunspot number, R, from 1610–1715. Boulder (US, CO): National Geophysical Data Center NOAA, updated October 24, 2007. Retrieved from http://www.ngdc.noaa.gov/stp/SOLAR/ftpsunspotnumber.html

Paliska, D. Kerma, S. Čop, R., & Bonin, F. (2015). An attempt to demonstrate the influence of Maunder minimum climate on salt production and it´s price in the Slovenian Istria (Sečovlje salt-pans). *Annales, Series historia naturalis, 25(2),* 163-172.

Palmer, S. J. Rycroft, M. J., & Cermack, M. (2006). Solar and geomagnetic activity, extremely low frequency magnetic and electric fields and human health at the Earth's surface. *Surveys in Geophysics, 27*(5), 557-595.

Pustilnik, L.A., & Yom Din, G. (2004). Space Climate Manifestation in Earth Prices – From Medieval England up to Modern USA. doi.10.1007/s11207-005-5198-9 Retrieved on July 2017 from https://arxiv.org/ftp/astro-ph/papers/0411/0411165.pdf

Rodgers, L. J., & Nicewander, W. A. (1988). Thirteen Ways to Look at the Correlation Coefficient. *The American Statistician, 4*(1), 59-66.

SILSO. (2014). Yearly mean total sunspot number [1700–now]. SILSO World Data Center – Sunspot Number and Long-term Solar Observations, Royal Observatory of Belgium, online Sunspot Number catalogue. Retrieved from http://sidc.oma.be/sunspot-data/

Stigler, M. S. (1989). Francis Galton's Account of the Invention of Correlation. *Statistical Science, 4*(2), 73-86.

Sterman, J.D., (2000). *Business Dynamics: Systems Thinking and Modeling for a Complex World*. Boston: Irwin McGraw-Hill.

Svensmark, H. (2000). Cosmic Rays and Earth's Climate. *Space Science Reviews, 93*, 155-165.

Swift, J. (1726) *Gulliver's Travels,* Part III A Voyage to Laputa, Balnibarbi, Luggnagg, Glubbdubdrib, and Japan. Retrieved in July 2017: http://www.gradesaver.com/gullivers-travels/study-guide/summary-part-iii-a-voyage-to-laputa--and-japan

Zavod Republike Slovenije za statistiko [Slovenian Department of Statistics]. (1971). *Statistični letopis Socialistične Republike Slovenije 1971 [Statistical Yearbook of the Socialist Republic of Slovenia 1971]*. Ljubljana: Zavod Socialistične Republike Slovenije za Statistiko, p. 292.

Zavod Republike Slovenije za statistiko. (1992). *Statistični letopis 1992 [Statistical Yearbook of the Republic of Slovenia 1992]*. Ljubljana: Zavod Republike Slovenije za Statistiko, p. 340.

Zavod Republike Slovenije za statistiko. (2013). *Statistični letopis 2013 [Statistical Yearbook 2013]*. Ljubljana: Statistični urad Republike Slovenije, p. 423.

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