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THE INFLUENCE OF THE SUN ON OUR LIVES

Abstract: *The paper first introduces the sunspot cycles and discusses the relationship between the solar cycles and the 12-year Chinese calendar. The latter has a significant impact on the lives and thinking of some East Asian countries and the emigrants from those countries. Western civilization considers solar cycles and their impact on human life only as solar astronomy and geomagnetism. Through the established effects on life on Earth, the life span of an individual is the starting point through which the paper represents the long-term influence of the Sun on us.*

Keywords: *solar cycles, geomagnetic field, impact on the biosphere, Chinese zodiac, impacts on humans and human society*

1. Introduction

Thinking about the impact of the Sun on life on Earth, on the individual and human society, is millennia-old and is still present today. The Stone in village Krkavče in Slovenian part of Istria (Figure 1) is not only an archeological monument but a ritual stone, which serves as a central part of an event organized by local church for local people and neighborhood pilgrims (Puhar & Pleterski 2005). The Sun's radiation is the basis for Earth's development, which occurs in the Earth's surface layer, in a gravitational and geomagnetic field. They are also affected by the Sun by changing its relative position and by changing activity. The Earth's magnetic field protects life on our planet from cosmic rays and prevents the solar wind from blowing away its atmosphere. The solar wind is a stream of elementary particles that emanate from the Sun in plasma and propagate into interplanetary space at an average speed of between 300 and 800 km/s.

In exceptional cases, this speed also exceeds 2000 km/s (Svalgaard & Wilcox, 1978).



Figure 1. Krkavče. The northeastern image on the Stone (Puhar & Pleterski 2005).

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In Slovenia, there is a geomagnetic observatory with the international code PIA (Piran, Slovenia), which regularly sends measurement data to INTERMAGNET (International Real-time Magnetic Observatory Network), an international information network for the exchange of measurement data on the state of the geomagnetic field. When presenting the results of routine measurements at this observatory, people from its immediate surroundings also responded. Gradually, an analysis of the Sun's influence on salt production during the Maunder minimum and the arrival of foreign tourists in Slovenia in 1948 – 2012 was created (Jere Jakulin & Čop, 2017) In the mosaic of evolving theories in the Sun's influence on people and human society, we created this article on a basis of exact measurements with technology of geomagnetic observatory PIA Piran. For the safe and reliable operation of the geomagnetic observatory, we also had to recognize the negative impact of the Sun on mobile communication, which has become one of the foundations of modern civilization in this century. Regular daily monitoring of the Sun's influence on the geomagnetic field (Figure 2) allowed us to detect additional influences on the local geomagnetic field: weather disturbances (Čop, 2015) and tensions of the Adriatic tectonic microplate (Čop, Rasson, Bilc, 2021). Shortly after the first regular measurements of the Earth's magnetic field (Čop et al., 2011) we observed an association of 'dead nights' with the onset of geomagnetic storms. Farmers and hunters in some parts of Slovenia know the 'dead night' as that night in the summer, when wild animals and insects fall silent and calm down. We have also observed that people with cardiovascular disease or dementia deteriorate during geomagnetic storms (Dezeljin & Čop, 2013). At the lowest level of geomagnetic storm G1 (Figure 2), the largest difference in the

absolute value of the Earth's magnetic field vector $dF = 53.8$ nT or 0.11% concerning its mean value $F = 47852.4$ nT as at mean geomagnetic latitudes.

Both places in Slovenia, where we set up a geomagnetic observatory, near the village of Kovk above Ajdovščina and near the village of Sv. Peter above Sečovelje, are in the special protection area and without a protective fence. This direct contact with nature allowed us to directly observe changes in forest animal populations as well. Thus, in three consecutive years, locusts, ants and scorpions first predominated in the construction of the observatory on Sinji vrh, the following year the population of rabbits stood out and last year they were very annoying mice.

When dealing with the salt yield in the Piran salt pans during the Maunder minimum, the Venetian economic policy proved to be characterized by the fact that there was never any kind of merchandise in deficiency or in abundance on the market and that they kept the prices of these goods (Bonin, 2016). This fact had an impact on their legislation and state contracts. Although this republic has existed for more than eleven centuries, it has not struck a balance with natural cycles in state contracts to produce sea salt. As a result, it became an interesting Chinese civilization, the only one that has existed continuously for over 7,000 years and has also left behind written sources (Kuiper, 2011). Chinese civilization has gone through great changes in its history. The organization of the old Chinese society has been similar to the organization of modern Western societies. Today, it differs from the decline of society in recognizing the values of the Chinese philosopher Confucius (Kong Fu Zi, 551 BC – 479 BC) and in high family morality (Xia, 2014).

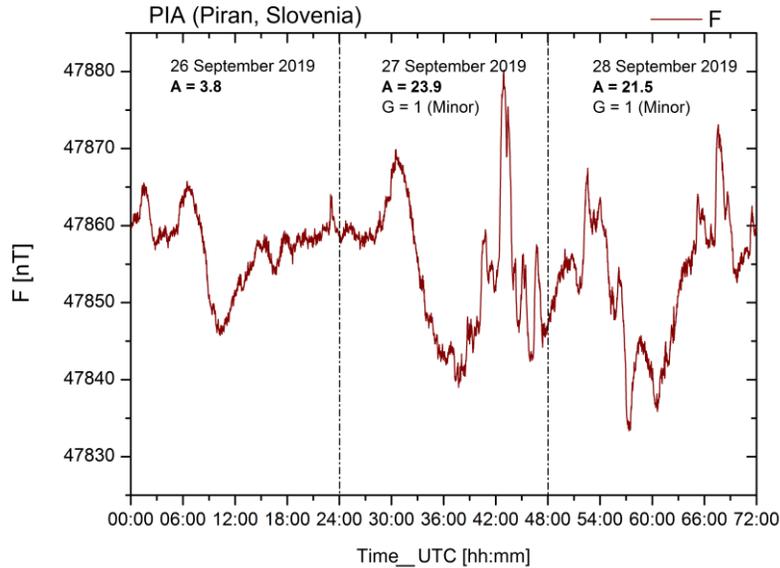


Figure 2. The Earth's local magnetic field description by the daily geomagnetic index A (Amax = 400). On the third day, a geomagnetic storm of level G1 (Minor) occurred, which reached level G2 (Moderate) globally

2. Sunspots

Scientists observed sunspots before introducing the telescope into astronomy, with the naked eye in special conditions, such as forest fires or through the smoke of temple fires. The oldest records of sunspots are from China, dating from 28 BC to 1638. From the period before the invention of the telescope, there are similar records in chronicles from Japan, Korea and Russia (Bray & Loughhead, 1964). The belief that the Sun is a perfect disk existed in Western civilization until the introduction of the telescope into solar physics in 1611. Galileo Galilei (1564–1642) and Christopher Scheiner (1575–1650) (Galilei & Scheiner, 2010) were not the first to observe sunspots through a telescope in the first half of the 17th century but were the first to attribute them to changes in the surface or atmosphere of the Sun (Figure 3). Scheiner was also the first to notice that the faster the sunspots travel, the closer they are to the solar equator. The Sun's rotation thus depends on

the solar latitude, which, according to an observer on Earth, effectively rotates in 27 days (Gilman, 1974). Sunspot cycles were discovered in the first half of the 19th century by Heinrich Schwabe (1789–1875) (Arlt, 2011). Their discovery is one of the most important discoveries in modern astronomy. Human current knowledge about the action of the Sun, which directly affects the Earth and life on it, stems from this discovery.

The longest collection of daily data in science is a collection of daily sunspot data collected over the last 400 years. After discovering sunspot cycles, the collection organized the Swiss astronomer Rudolf Wolf (1816–1893). After 160 years, these data were reviewed and supplemented (Clette et al., 2014). Only successfully verified data and the number of sunspots and their records were reconciled (Figure 4). The marked maximum from the middle of the last century has disappeared in the new and revised database. Solar activity has been very stable over the last 250 years (SILSO,

2019). Various scientific disciplines, including climatology, used the data on the number of sunspots (The Sun and Climate, 2000). They became important in geomagnetism after 1852 when Edward Sabine (1788–1883) announced (Sabine,

1852) that the frequency of geomagnetic storms changes according to sunspot cycles (Maunder, 1904). The discovery in the previous century showed that solar cycles modulated the inflow of cosmic rays to the Earth (Hathaway, 2015).

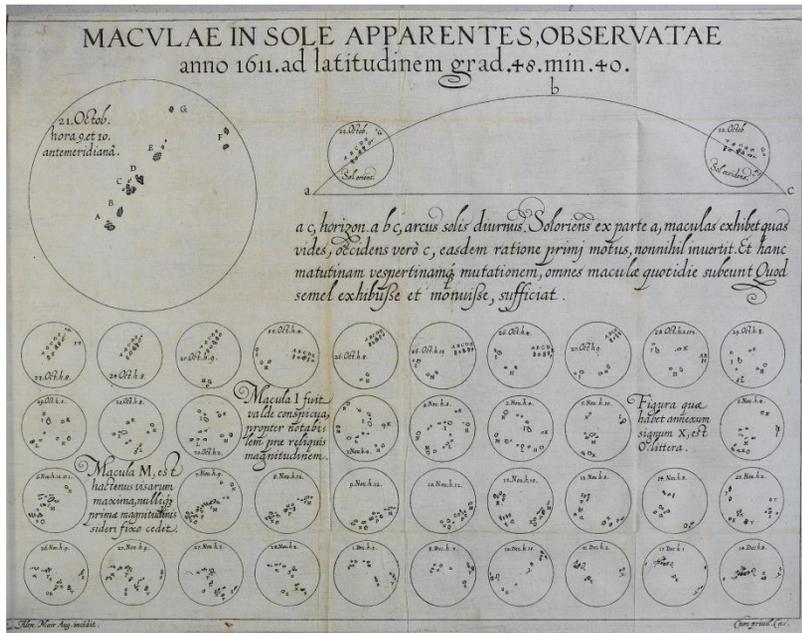


Figure 3. Report on the observation of Christopher Scheiner's sunspots from 21 October to 14 December 1611 (Scheiner, 1612)

George Ellery Hale (1868–1938) determined, using measurements of the light spectrum in 1919, that sunspots are essentially magnetic anomalies on the Sun's surface (Hale et al., 1919). After two consecutive cycles of sunspots, the sun also changes the direction of its magnetic field. Therefore, the sun is a huge sphere of plasma that is electrically conductive and very active when observed over a long period. Joseph Larmor (1857–1942) explained that a self-excited single-pole electric dynamo can generate electric currents in the Sun (Larmor, 1919). This statement received its confirmation in the second half of the last century. Various models, which illustrated

the inner operation of the Sun were developed (Tiwari & Kumar, 2017) for better understanding the Sun's. The Sun is the centre of our planetary system and contains almost the entire mass of this system. Its activity changes cyclically. Data on the daily change in sunspots are available from 1610 onwards and comprise 36 solar cycles. Statistical processing of these data yielded a mean solar cycle length of 11.06 ± 1.5 years and a medium of these values between 10.7 and 11.0 years. These data indicate pulsating, which we cannot explain by internal processes on the Sun (Solheim, 2013). The planets' rotations around the Sun, cause constantly movement planetary

system's mass center, and consequently also the position of the Sun on it. The Sun and the planets interact with each other and exchange both gravitational and inertial impulses. Due to this, the surface of the Sun waves and the most influential are Venus, Earth, Jupiter, and Saturn, which have sidereal periods of 0.615, 1.00, 11.862, and 29.458 years. The sidereal period is the time when the planet returns to the same point on the celestial vault concerning the fixed stars. The results of the analysis of the daily number of sunspots from the 1st to the 23rd solar cycle, from 1755 to 2008 (Scafetta, 2014), using the spectral analysis MEM (maximum entropy method), contain three characteristic periods: 9.98, 10.9 and 11, 86

years (Wilson, 2013). MEM analysis is a form of FFT (fast Fourier transform) analysis for transforming from time to frequency space. The central period of 10.9 years is equal to the period of the solar dynamo, and the shorter side period of 9.98 years is close to the spring periods of Jupiter and Saturn. This position varies from 9.5 to 10.5 years and averages 9.93 years. The longer side period of 11.86 years is equal to the sidereal period of Jupiter. The two largest outer planets, Jupiter and Saturn, influence the solar dynamo by their gravity, to which the central period can be attributed. Celestial mechanics can therefore explain the length of solar cycles. Three periods differ from each other in length.

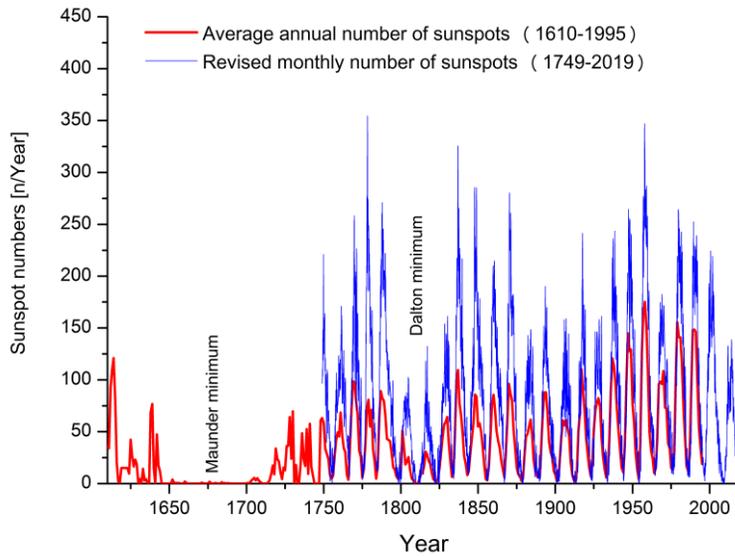


Figure 4. Average annual number of sunspots counted from 1610 till today and revised the monthly number of sunspots in 1749–2019 (SILSO, 2019)

On the data set on the monthly number of sunspots in 1749–2019, we did a spectral analysis of MSA (mean square amplitude). MSA analysis is also one form of FFT analysis for transforming from time to frequency space. This analysis presents the results in Figure (Figure 5), which clearly shows the central period of 10.82 years, which belongs to the basic sunspot cycle,

and both lateral periods of 10.02 and 11.76 years. The period of 10.02 years is close to the spring period of Jupiter and Saturn, which averages 9.93 years, and the period of 11.76 is close to the sidereal period of Jupiter, which is 11.86 years. The syzygy cycle of the planets Jupiter – Venus – Earth is on average 11.07 years long and close to periods of 10.41 years as well as 11.27 years.

In astronomy, syzygy represents three or more celestial bodies placed in an approximately straight line. Also, the spectral analysis of MSA on an otherwise

smaller data set was used to provide information on the operation of the planets on the solar magnetic dynamo.

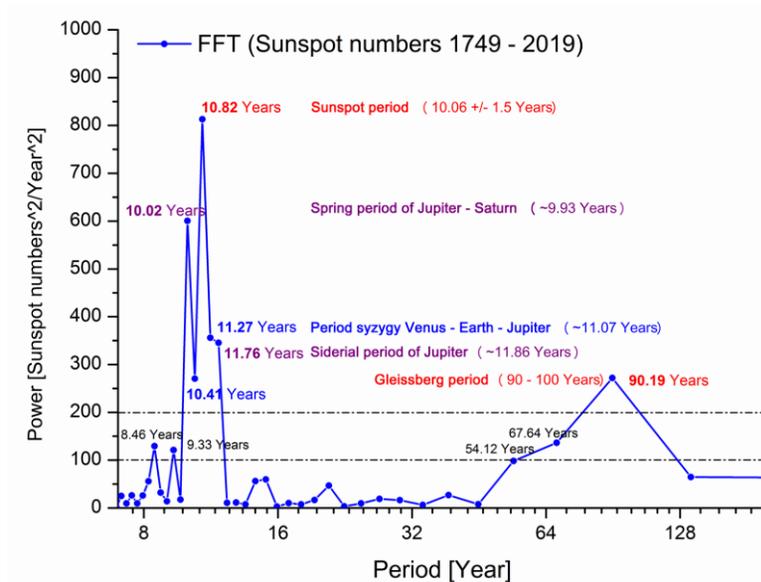


Figure 5. Expressive periods of the power spectrum of solar cycles obtained by the MSA method (mean square amplitude) in the monthly data analysis on the number of sunspots in 1749 – 2019

In the spectral analysis of the MSA data set on the monthly number of sunspots in 1749–2019, a cycle of hundred years with a length of 90.19 years also appeared (Figure 5). This period belongs to the longest yet demonstrable natural cycle with a duration of 90–100 years. It is also called the Gleissberg cycle after the German astronomer Wolfgang Gleissberg (1903–1986). We can see its demonstration by changes in aurora borealis, the age of centuries-old trees, and the radioactive isotopes beryllium 10B and carbon 14C (cosmogenic isotopes). This cycle can be an underlying cause of the change in global temperature in previous periods and explain the Maunder and Dalton minima formation (Figure 4). The periods of 8.46 and 9.33 years belong to the higher harmonic

frequencies of the sunspot cycle, and the periods of 54.12 and 67.64 years to the higher harmonic frequencies of the hundred-year cycle (Figure 5). We can also explain all these higher harmonic frequencies with the help of celestial mechanics.

3. The impact of the Sun on the biosphere, on people and human society

The sun affects the Earth directly or indirectly through radio and microwaves, infrared rays, visible and ultraviolet light, X-rays and cosmic rays, and solar wind. Impacts on life on Earth are intertwined, so their study is challenging and usually cannot be explained by a single mechanism. The sun also affects the earth's magnetic field,

most strongly through the solar wind. Some living beings use this magnetic field for orientation in space. The behavior of salmon, trout, bees, bream and domestic pigeons has been the most studied. These animals detect very small changes in the magnetic field (Figure 2). The effect of a change in the geomagnetic field on living beings cannot be direct, but only through resonant absorption. Thus, very small changes in the geomagnetic field that affect living beings on Earth represent an additional problem in finding mechanisms that change the biological state of an individual organism when magnetic storms occur.



Figure 6. Photograph of rod-shaped bacterium MSR-1, taken using a TEM (transmission electron micrographic) electron microscope (Alphandéry, 2014). Chains of magnetite nanocrystals are visible in the bacterial cell

Among the most researched living beings that orient themselves with the help of a geomagnetic field are some bacteria (magnetotactic/magnetosensitive bacteria). These bacteria have been known for the last fifty years (Bellini, 1963; Blakemore, 1982) Their cells contain nanocrystals of

ferromagnetic compounds, most made of magnetite (biogenic magnetite, Fe_3O_4), encased in a lipid bilayer membrane (Alphandéry, 2014). They act as miniature compasses and allow bacteria to swim directionally in the water column (Figure 6). Magnetite nanoparticles smaller than 200 nanometers are also found in animal tissues, allowing some to navigate. We can find these nanoparticles of magnetite in the human brain, heart, spleen, and liver. We still don't know what their role is. We only know that their excessive concentration in brain tissues, they are a sign of degenerative diseases of the nerves, such as Alzheimer's, Parkinson's, and Huntington's disease (Fuller & Dobson, 2007).

In the six years to 2000, researchers carried out a study systematically using the CTG (foetal cardiocography) method in the Murmansk Region on the Kula Peninsula in the Russian Federation's Arctic Circle. The CTG method enables monitoring of the fetal heart rate and uterine contractions during pregnancy and childbirth with the help of electronic equipment. The results showed that increased geomagnetic activity had an extremely strong effect on 15% of unborn children. According to researchers, this means that 10–15% of people in each generation are sensitive to geomagnetic storms. This effect on people with cardiovascular disease has been most reliably identified, namely a negative correlation, and less reliable are the effects on the mentally ill and the number of suicides (Palmer et al., 2006).

Based on the monitoring of heart rate variability over a long period, a linear correlation was found with the planetary geomagnetic indices K_p ($r = 0.50$) and A_p ($r = 0.35$) (Alabdulgader et al., 2018). A change in heart rate variability is a change in rhythm between individual heartbeats. Geomagnetic disturbances have the greatest influence on it at higher geomagnetic latitudes, and in medium latitudes, this influence masters weather disturbances. In

the last ten years, more and more research on the impact of geomagnetic disturbances on humans has moved to laboratories where tests can be performed in a shorter time (Pishchalnikov et al., 2019). Recent studies have also shown that a change in the Earth's magnetic field in humans unconsciously changes the shape of their alpha waves (Wang, et al., 2019). Alpha waves are electromagnetic waves of the human brain with a frequency of 8–13 Hz, generated in a state of relaxation with closed eyes. The research, therefore, suggests the existence of biological magnetic field sensors in humans as well, but their existence is still not reliably proven.

4. Chinese zodiac

Chinese astrology and thus the Chinese zodiac (Chinese year) was formed 4000 years ago and then supplemented. It is the result of life experiences that have been accumulated through generations and passed down from generation to generation as the greatest wealth (Yip & Cheung, 2002). Today, the inhabitants of East Asia (China, Hong Kong, Vietnam, Korea, Cambodia, Taiwan, and Japan) follow it. These inhabitants believe that the date of birth affects both the characteristics of the individual and his life.

In the Chinese zodiac, in a twelve-year cycle, each year is named after different animals: dog, dragon, goat, horse, monkey, buffalo, pig, rabbit, rat, rooster, snake, and tiger. Each of these animals, some of which are more popular than others, has certain characteristics. The Chinese zodiac animals are tied to individual years and not to the constellations on the celestial vault, as is the case in Western astrology. Their distribution depends on the position of the Moon and the planet Jupiter. The twelve-year cycle of the Chinese zodiac is close to the 11.85-year sidereal period of Jupiter and also basic period of sunspots. The transition between the individual twelve-year cycles of the

Chinese zodiac is not unambiguously determined by our calendar.

5. The life expectancy of Americans of Chinese descent

U.S. residents of Asian descent live nearly eight years longer than those of European descent. The largest difference between these two ethnic groups is mortality from a heart attack (24%) and cancer (18%). The reason may be in the healthier traditional cuisine, which is still cultivated by Americans of Asian descent and because they smoke less frequently than members of other ethnic groups (Acciai et al., 2015).

An extensive study (Phillips et al., 1993) compared data on the deaths of Americans of Chinese descent. If they suffer from a serious illness, they die 1.3 to 4.9 years earlier than the average for their ethnic group. The more they follow their tradition, the shorter their lifespan. Therefore, researchers attributed the shortened life expectancy to Americans of Chinese descent who were born after Chinese astrology and medicine at an unfavourable time, primarily psychosomatic processes. These are not precisely defined, but they are reflected in a more stoic attitude or coming to terms with the hopeless situation without the possibility of recovery in which these patients found themselves.

In Hong Kong, 92% of the population is of Chinese descent. The birth analysis data in the period 1960–2009, showed that this number is increasing the most due to the immigration of young women (Grech, 2015). On average, 485 girls were born per 515 boys. This ratio is the ratio of live-born boys to the number of all live-born children (M/F ratio). According to the study, the Hong Kong parents' belief in the Chinese zodiac, influences the ratio. The M/F ratio increased most markedly in 1975 – 1976, in the year of the dragon. It differs from the previous value of 0.5139 to the value of 0.5202 (+ 1.23%). The M / F ratio is generally increased by

prolonged wars and increased radioactive radiation due to nuclear tests and accidents at nuclear power plants. The ration decreases by ecological disasters, economic downturns, and natural disasters such as earthquakes, fires and floods, and short-lived war.

6. The life expectancy of people in Norway

A study based on demographic data from 1676 to 1878 in Norway found that women lived on average 5.1 years less and men 5.3 years less if they were born at the solar maximum than those women and men born during the time of low solar activity. The researchers obtained this result when they extracted all incomplete data from the available data set and further checked them according to the social and economic situation of the individual, ecological conditions of the individual group, year of birth and age of his mother at first birth. All these additional conditions affect the life expectancy of an individual. Researchers have considered solar activity, measured by the number of sunspots on the solar disk, as an eleven-year cycle in which the Sun is little active for eight years and very active for three years (Skjærvø et al., 2015).

The authors of the above study of the population in Norway attribute the change in life expectancy of the then Norwegians to the lack of vitamin B9 (folic acid) during maternal pregnancy. Vitamin B9 affects the development of DNA (deoxyribonucleic acid) and cell membranes in the developing organism. This vitamin decomposes faster under the influence of increased radiation of ionizing UV rays (ultraviolet rays, $\lambda = 10 \text{ nm} - 400 \text{ nm}$) during the solar maximum. In addition, to the increased activity of the Sun during the maximum cycle of sunspots, climate change and the state of ozone in the atmosphere cause increased UV radiation in our surroundings. The effect of vitamin B9 on the developing fetus has been confirmed

by medical practice as protective (Argyridis, 2019).

7. Discussions

People born during peak solar activity have a shorter lifespan than those born during low solar activity. Ancient Chinese astrology, which is linked to the sidereal period of Jupiter by the length of the Chinese year, also considers the correlation between the length of one's lifespan and solar activity. Jupiter has the greatest influence on the tide of the solar surface and, thus, the solar cycle length.

The lifespan of an individual is the most influenced by his lifestyle. If it ties to the traditional attitude towards life and considers the cycles in nature, then the probability of its long life is also the highest. In exceptional cases, when an individual suffers from an incurable disease, the length of his life is significantly affected by the way he thinks (Phillips, 1993), which does not prevail over the effects of natural cycles; this confirms the impact of (and belief in the Chinese zodiac) parents in Hong Kong in the number of births in the periods specified by the Chinese calendar.

Sun with its various forms of radiation and the solar wind influences life on Earth and thus also in humans. However, the relative changes in these impacts, measured at the Earth's surface and over time, are very small (The Sun and Climate, 2000). Therefore, the mechanisms that change the biological state of an individual are very difficult to detect. Furthermore, the effects of the Sun on the biosphere are intertwined, so it is usually impossible to explain these effects by a single mechanism.

Science has not yet discovered human biological sensors for magnetic field changes, and research shows that these sensors exist. The unconscious effect of a change in the magnetic field on brain alpha waves has been established. In each generation, 10 – 15% of people are

extremely sensitive to changes in the geomagnetic field. These effects on people with cardiovascular disease are the most researched. The linear correlation between the change in heart rate variability and the geomagnetic index A, which indicates the geomagnetic activity of an individual day, is 0.35. This correlation is even slightly lower if the correlation exists over a longer period; this is typical of sociological studies. We established the correlation of 0.30 between the annual number of sunspots and the annual number of tourist arrivals in Slovenia in 1949 – 2012.

Although the Sun's influence on people is extraordinary, we should not attribute everything to the Sun (Daniele, 2011). To distribute the IQ obtained based on school tests in Italy, the researchers sought an excuse in the power of ultraviolet radiation from the Sun across latitude.

8. Conclusions

In determining the impact of the Sun on people, their activity, and the length of their lives, data relating to these connections and the choice of the right tool for processing them are important. Databases created over a long time cannot be repeated. We adapted

the appropriate tools for processing the data which we discussed in the paper. With the inductive method, we obtained the theses and theories derived from the results of these treatments. (Glaser & Strauss, 1967). The evolution of appropriate tools and new ideas in the field of the functioning of the Sun and its influence needed the time of two generations. In addition, this evolution is very slowed since the slow spread of this knowledge, which is not exactly in trend in Western civilization.

The development of science in Western civilization depends on time measurement. Today, when the nanosecond is important ($1 \text{ ns} = 10^{-9} \text{ s}$), periods measured in decades have lost their vital significance. There exists an attempt to exceed the biological clock (Dunlap & Loros, 2017), which is affected by changes in light and temperature. However, we should mention that no other level of civilization in history has been as sensitive to changes in the Sun as the current Western civilization. It would be most threatened by strong eruptions on the Sun, reaching the Earth (Mörner, 2016). They would cause the breakdown of communication systems (Čop, 2016), cut off the electricity supply, and affect information and transport systems.

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