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## The effect of sunspots on drought in Bojnord city

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### ABSTRACT

During the drought, it will affect people's lives and has been known as a creeping phenomenon. It's beginning isn't completely understood, so if we can start to anticipate drought and the relationship between it ,and its causes can be discovered, we can better prepared to deal with it and closely plan for our everyday life, so during drought, minimal damage to water , agricultural , social and economic supplies will occur.

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## INTRODUCTION

Drought means lower expected rainfalls in one year than in the long-term rainfall in a region and unexpected decline in rainfall in a given period of time in an area that is not dry. Drought isn't a constant feature of the area and can occur in any weather conditions (Kaviani, Alijany 1371). Drought has significant effects on the living organisms in an area, especially in arid and semiarid regions, leading to increase dryness of the air and soil's evaporation, plants don't grow so soil erosion is increasing with the loss of vegetation. Soil erosion causes water pollution by wind endangers the lives of all living organisms. (Shayan and Choobineh 1379).

Scientists say cause of drought is because of climate change in each area. Some also believe that the sunspot is cause of drought. Different types of drought are hydrological, agricultural, economic and social drought. (Aliasghar Taghvaei *et al* 1387).

Tremendous amount of evidence suggest that incidence of severe transient solar events on the earth's climate and the occurrence of long-term changes in solar energy output in the earth's climate is very effective and decisive.

Discovery of future connections between sun and earth enables us how to explain the physical causes and reaction between these two parameters. When the connection between them is clear, science will become the most basic tool for climate and weather forecasting (Yusef 2000).

*Research history:*

The connection between sun and the atmosphere on climate changes has been established, among the evidence that may be involved in the research are Jacob's researches (1998), Gissen *et al* (2003), Kakhlin & Tang (2003-2004), Schmitt *et al* (2006), Howit Achten (1997), Arya *et al* (2000), Labtizek (2001). (Journal of Geographical Research, no 99).

Jahanbakhsh and Edalatdoost (1387) also studied the impact of solar activities on annual rainfall in Iran and reviewed solar influence on climate and showed a reverse negative connection between annual rainfall and sunspots. Zarin and Mofidi (1384) also emphasized on the influence of solar activity and its effects on earth's climate. (The study of Middle East region and Iran).

The project aims to determine the effect of sunspots on drought between 1357 until 1390 in Bojnord and weather statistics according to emergence of 11-year solar spots, have been studied(temperature and rainfall) in Bojnord during 1357-1368-1379 and 1390.

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### Data and Methods:

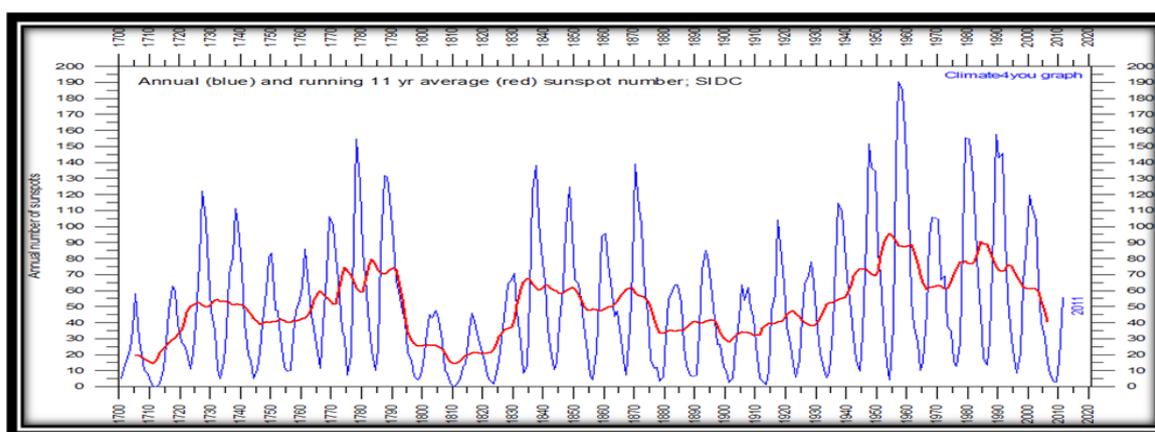
These steps have been done for project, they are: 1- obtaining Meteorological Agency's rainfall data (in North Khorasan (The annual minimum and maximum temperature, hours of sunshine, evaporation, total rainfall, annual crop rainfall and wind speed) and Regional water Authority in Bojnord during a 35- year statistical period from 1356 till 1390. 2- studying tables and charts of the rise time and the numbers of sunspots between 1900 till 2012 in Jahanbakhsh and Edalatdoost article (1384), website www.climate4you graph, NASA website and U.s Geophysical Institute(NGDC). Standard rainfall indicator SPI is used to review drought period and is calculated as following( Hossein Ansari 1387):

$$SPI = \frac{xi - x}{sd}$$

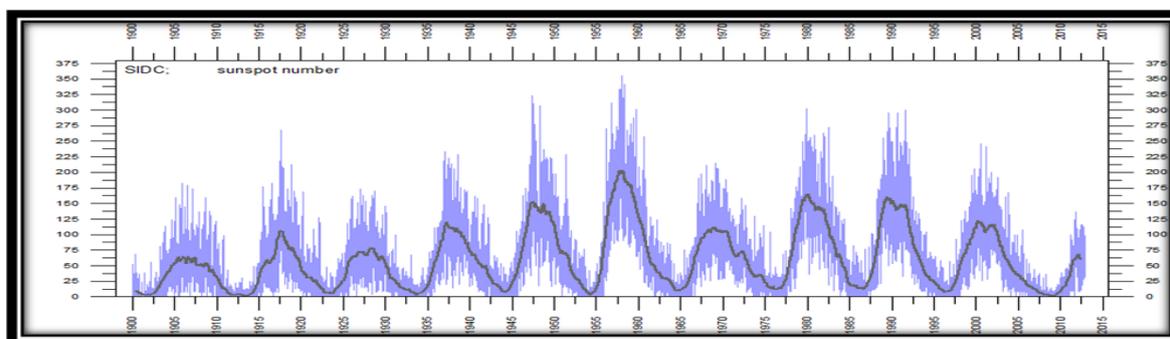
Where, SPI is standardized rainfall, xi is the rainfall amounts in the time scale, x is the average rainfall and sd is the standard deviation.

**Table 1:** Scale classification of wet, dry and normal periods' intensity by SPI method.

Condition	Extremely wet	Extreme wet	Average wet	Normal rainfall	Mild dry	Extreme dry	Extremely dry
SPI amount	2 or more	1.5 till 1.9	1 till 1.49	0.99 till 0.99	-1 till -1.49	-1.5 till -1.99	-2 and more



**Fig. 1:** The rise time and the number of sunspots per year-1700 till 2012 year.



**Fig. 2:** The rise time and the number of sunspots per day- 1900 till 2012 year.

Correlation and regression method is being used to determine the relation between sunspots and rainfall amounts as following:

$$r = \frac{\sum \frac{(xi \cdot yi)}{n} - (\bar{x})(\bar{y})}{(\sqrt{\sigma_x^2}) (\sqrt{\sigma_y^2})}$$

Where,  $r$  is the correlation coefficient,  $x_i$  and  $y_i$  are statistical data,  $\bar{x}$  and  $\bar{y}$  are average data,  $\sqrt{\sigma^2x}$  is standard deviation of  $x$ s and  $\sqrt{\sigma^2y}$  is standard deviation of  $y$ s.

The regression line equation:  $y = a.x + b$

where,  $a = r \cdot \frac{\sigma_y}{\sigma_x}$  and  $b = \bar{y} - a\bar{x}$  are computable (Method of least squares).

The years of 1357-1368-1379 and 1390 are the sample years for this research according to future explanation of sunspots and 11-year period and the rise time and synchronization appearance of them in these years in figure 1.

#### *Solar activity:*

The term solar activity contains all phenomena that are occurring in the sun (photosphere) or in its atmosphere (chromospheres). The occurrence of such phenomena on different time scale reflects the heterogeneous distribution of solar radiation caused by the presence or absence of active regions on the solar surface. Solar activity variations are short term and temporary term such as flares and corona mass exit including the cycle period of 16 months and long term cycle of 11-year of sunspots. Generally, there are two reasons for the change in sun, the first factor is due to the evolution of sun and its core and the second factor is the magnetic field of sun. The main elements that determine the intensity and structure of sun's magnetic field are the combinations of different levels of solar activity. Different spins generate a strong magnetic field near the base of convection zones. If the magnetic intensity exceeds a certain threshold, becomes unstable and is starting to rise in the sun surface in certain circles and finally reach the surface of sun through the convection zone. These field lines in sun's surface then loops back inside it. They are known as closed magnetic flux and a small fraction is carried by the solar wind into the space between the planets that are known to open magnetic flux. Closed magnetic flux cause several phenomena such as sunspots, phocolla, hot corona rings, bumps and etc (Mofidi & Zarin 1384). Sun is a big flaming ball that is formed by cloud of gas and suspended dust in the atmosphere. It is heated by the contraction of gas mass and dust, and in this way it was born. The temperature at the center of it is 15 million degrees Celsius, the surface temperature of it is 5500 degrees Celsius and the temperature at the surface of the sun is 2 million degrees Celsius. Sun is composed of hydrogen, helium, seven elements (oxygen, carbon, Neon, nitrogen, magnesium, iron and silicon) and there are 98000 helium atoms, 8500 oxygen atoms, 360 carbon atoms, 120 neon atoms, 110 nitrogen atoms, 40 magnesium atoms, 35 iron atoms and 35 silicon atoms in per a million of hydrogen in the sun. (Secretariat of Strategic National Geographic). A lot of energy is created by nuclear fusion in the sun. Nuclear fusion is the change stage of hydrogen nuclei into helium nuclei. In every second, 600 million tons of hydrogen is converted into helium and in per second, 4 million tons of mass loses. Sunspots are relatively dark areas on the sun's surface that contains a darker area in the center called Shades or Umbra and are called Penumbra with less blur in sides. Spots are usually double and are seen with the opposite magnetic poles (Zarrin and Mofidi 1384). The oldest documents in the spots corresponding to the Shang Dynasty in China around the 1200 BC. After that one of Aristotle's students called Teoferastoos (370 BC) wrote the primary source of sunspots. At the beginning of the 17<sup>th</sup> century with the invention of telescope, Galileo was the first who observed sunspots and concluded they are displaced. Shoveb in 1843 according to his astronomical observations of sunspots concluded that they reach to their maximum at intervals of 10 to 11 years. Although, at first no one cared to his discovery, Alexander Fan Humboldt in 1850 explained Shoveb's discovery in the third volume of his famous book (cosmology). After that the world knew 11-year cycle of Shoveb. This discovery was one of the key steps in understanding the sun and its impact on earth. The high energy of the earth is related to explosions in the sun's surface into space in every 11 years and again return to their initial position. Where as their temperature is cooler than the surface of the sun, their return create a pair of spots in surface of the sun. Fire flares should produce additional heat to compensate the ate cold spots, so the area which is closer to the spots becomes too hot and creates solar eruptions. Abundance and distribution of sunspots is almost periodic. The number of sunspots and their changes almost last to a 11-year period. In the first 5-6 years the number of them increase. Then in 4-5 years they will be reduced and at the end it may not be seen for several months until the new period will be start. Thus as result of increasing the number of spots, earth will be warm and drought expected.

#### *Geographical location of the study area:*

Bojnord city is located in North Khorasan Province and is the center. It is in 37 degrees 28 minutes north latitude and 57 degrees 20 minutes east longitude and at an altitude between 1000 to 2500 meters above sea level. Bojnord is 1010 meters above sea level. Average annual rainfall is changing from 153.1 mm to 404.6mm in this city. Liquid precipitation constitutes a significant portion of the total precipitation. The area affected by



According to SPI drought chart, can be found drought is related to 1985-91-2001-2013 and the amount of -1.5, -1.6, -1.2 and -0.8 respectively. They make significant increase during the statistical period mentioned above. Negative rates in Standardized Precipitation index indicate periods of drought. years mentioned above is coincident with the early appearance of sunspots ( except 1985 that is not included in our study and number of sunspots are very low and there are other causes for the drought in this year).

**Table 3:** maximum number of sunspot (geophysical institute of America)

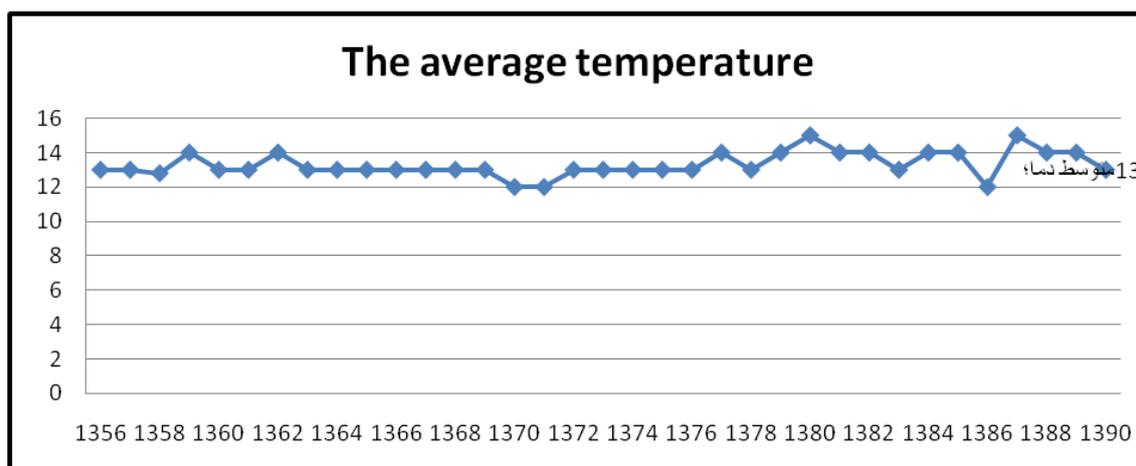
The average number of sunspot	Statistical period
93	1979
157.6	1989
119.6	2000
55.58	2011

#### Bojnord Temperature:

Solar eruptions and explosions warm up cold spots and sun's surface and it provides an uniform surface temperature. As a result of these activities and effect on earth's climate, we tried to investigate about temperature in Bojnord in the studied years.

**Table 4:** The average temperature & sunshine hours & annual evaporation

moon / year	Annual temperature	Annual sunshine hours	Annual evaporation	/ year moon	Annual temperature	Annual sunshine hours	Annual evaporation
1978	13.0	**	*	1996	13.2	2037.0	1617.2
1979	13.0	**	*	1997	12.9	2815.6	1665.1
1980	12.8	**	*	1998	13.2	2750.4	1898.0
1981	13.8	**	*	1999	14.3	2878.5	1886.8
1982	13.1	2297.6	*	2000	13.1	2947.0	1935.9
1983	13.1	2606.0	*	2001	13.8	2977.5	1875.8
1984	14.2	2521.6	*	2002	14.6	2732.5	1939.4
1985	13.4	2513.4	*	2003	13.5	2664.1	1418.6
1986	13.1	2651.5	*	2004	13.5	2596.3	1668.6
1987	13.2	2645.6	*	2005	13.3	2465.7	1645.5
1988	12.8	2646.2	*	2006	13.8	2888.8	1714.9
1989	12.8	2854.7	*	2007	14.3	2894.2	1823.0
1990	13.4	2839.3	*	2008	12.4	2984.0	1437.1
1991	13.2	2781.1	*	2009	14.5	2874.5	1584.0
1992	12.3	2621.3	*	2010	14.2	2730.7	1514.7
1993	11.8	2486.0	*	2011	14.1	2967.3	1776.6
1994	12.6	2364.8	*	2012	12.9	2775.6	1573.7
1995	13.1	2383.3	431.3				



**Fig. 4:** The mean annual temperature of bojnord . solar year ( 1356- 1390)

The survey showed that sunspots didn't have a significant impact in temperature rise and may be other reasons such as latitude, mountainous regions, and outside mass climate detracted effect of these parameters on temperature rise. A year after the appearance of sunspots, according to the evidence in figure 4, temperature has risen by 1 degree Celsius in Bojnord.

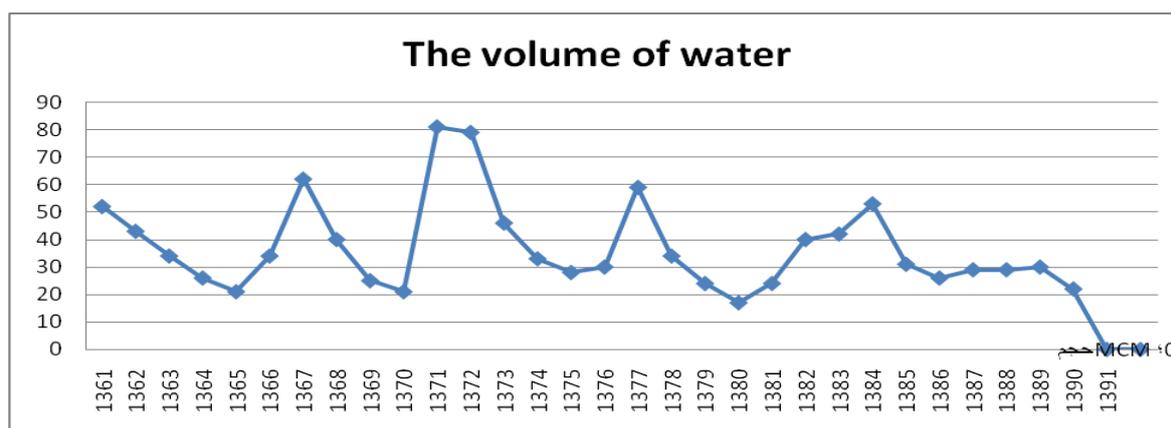
*Hydrological drought:*

If the meteorological drought will continue for a long time and amount of river flow or groundwater level decreases, leading to the occurrence of hydrological drought. This phenomenon is often caused by a deficiency or lack of winter precipitation within the mid-latitude. This kind of drought can be classified into 2 categories, surface water drought and ground water drought, based on the severity of meteorological drought. (Aliasghar Taghvaei *et al* 2008).

Rivers in Bojnord: Atrak River is the main river in this area. This river originates from LaleRoyan heights located 40km East of Quchan and after passing through the cities of Shirvan and Quchan enters Bojnord and extends to the Kazan Gaphe village after getting branches. This river forms the border between Iran and Russia with the length of approximately 90 km, then joins to Sambar River in Russian and at the end enters the Caspian Sea. About 130km of Atrak water flow is in bojnord city. So Baba Aman, Bazkhane, Badranlu, Hamed, Chenaran, Firouzeh and Mehnan rivers and so many waterways in the city determine how much water is in Atrak. Too much amount of it increases Atrak's water and vice versa.( Basic Studies of Water Resources in Bojnord). Lack of rainfall is the result of sunspot's effect on drought and lack of rain decreases water in rivers, so Baba Aman river flow was examined in the study years.

**Table 5:** river discharge baba aman on solar year ( 1361- 90)

year	average	(mcm)volume	year	average	(mcm)volume
1361	1.64	51.65	1377	1.88	59.15
1362	1.35	42.51	1378	1.08	33.98
1363	1.07	33.76	1379	0.76	23.86
1364	0.81	25.57	1380	0.55	17.19
1365	0.68	21.30	1381	0.77	24.23
1366	1.09	34.29	1382	1.28	40.50
1367	1.96	61.68	1383	1.36	42.95
1368	1.28	40.46	1384	1.68	53.03
1369	0.78	24.75	1385	0.998	31.47
1370	0.67	21.07	1386	0.837	26.41
1371	2.58	81.29	1387	0.923	29.11
1372	2.51	79.22	1388	0.910	28.68
1373	1.44	45.50	1389	0.960	30.26
1374	1.04	32.94	1390	0.727	22.94
1375	0.88	27.73	1391		
1376	0.96	30.19	1392		

**Fig. 5:** annual river discharge baba aman on solar year ( 1361- 90)

*Correlation and regression sunspots and rainfall in Bojnord:*

Answer of correlation coefficient equation is -0.2 that is negative and close to zero.

Year	Annual precipitation $x_i$	The annual number of sunspots $y_i$	$(x_i - \bar{x})^2$	$(y_i - \bar{y})^2$	$x_i.y_i$
1979	274	93	1600	196	25482
1990	190	157.7	1936	2601	29830
2000	262	119.8	784	169	31440
2012	208	55.58	676	260	11648
مجموع	$\approx 934$	$\approx 427$	7996	5567	98300

$$\sigma_x^2 = \frac{7996}{4} = 1999$$

$$\sigma_y^2 = \frac{5567}{4} = 1392$$

$$\sum \frac{x_i.y_i}{n} = 24575$$

$$r = \frac{24575 - 25038}{(44.7)(37.3)} = -0.2$$

$$a = (-0.2).(0.83) = -0.16$$

$$b = 107 - (-0.16)(234) \approx 144$$

$$y = -0.16x + 144$$

#### Conclusions:

The obtained results in the present study as well as other studied show the correlation between solar activity and climate variables in Bojnord. In fact, one year after the appearance of spots and their gradual rise, rainfall has decreased in Bojnord. And in SPI scale, and during the increase of spots, Bojnord becomes mild dry. However, a weak association is seen between these activities and the mean annual temperature in Bojnord. Maybe other reasons such as latitude, mountainous region, climate masses out of region and ...play role. As the connection between sunspots and rainfall in Bojnord showed, the correlation coefficient is negative and close to zero. According to the statistical concepts, if the correlation coefficient is negative, y decreases with increasing values of x and vice versa determining y can be done with much more error if the correlation coefficient is close to zero (Bakhshalizadeh and Pasha 1380). Therefore, the above descriptions can be concluded that there is an inverse relationship between the emergence and increasing number of sunspots and rainfall in Bojnord. due to solar activities since 1390 and the gradual increase in number of them in a period of 5 or 6 years and a relative increase in temperature, reasonably rainfall reduction be expected in the year 1391 in Bojnord and these claims can also be seen in statistical data of Khorasan Agricultural Organization. According to statistical analysis, the rate of rainfall cropping seasons in 1390-91 and 1391-92 has been 62.1mm and 58.1mm respectively that compared to the previous year has been %6.4 decline and the average temperature increase of %2.7 have been shown for the current crop year compared with the same period a year ago. Therefore, drought can be presented in the coming years with higher than expected and it's better to provide the necessary measures before the occurrence and reduce the amount of damages.

#### REFERENCES

- Bakh Alizade, Sh., A. Pasha, 2012. Static and modeling, publisher of educational books, 13<sup>th</sup> edition
- Basic, 2012. researches organization of water sources of Bojnord city.
- Eslami, R., 2011. sun spots. strategic office of state geography in North Khorasan.
- Jafari, T & *et al.*, 2012. Province realizing of North Khorasan .publisher of educational books, first edition..
- Jahanbakhsh, S.M., Adalatdoot, 2008. the lake of Urumia as a criteria about relation between sun spot and climate in north west of Iran, Journal of geographic researches, N 99.
- Jahad-e Keshavrzi, 2011. organization, forecasting of culture year for.
- Kavyani, M.B., Alijani, 2012. principal of climatology, publisher of Samt 13<sup>th</sup> edition.
- Meteorological administration of North Khorasan, 2011-2012. Shayan, S.M, Choobine. (2012). General geography, publisher of educational books, 14<sup>th</sup> edition.

- Taqavi, A., 2008. criteria of through,publisher of agriculture and natural resources of Razavi Khorasan.
- Zarrin, A.A., Moffidi., 2005. modul ation of sun spots activities and its effect on climate of the earth,geographic journal of Sarzamin,N 8.
- [www.ngdc.noaa-go](http://www.ngdc.noaa-go)
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