

Statistical Analysis of Earthquakes in Iran - Yazd Province in the years 2006 to 2009

Seyed Ali Almodarresi¹, Kazem Yavari Nasab² (Corresponding author), Elahe Alsadat Mirkhalili³

¹ Ph.D. in Geomorphology, Department of Remote Sensing and GIS Engineering, Faculty of Islamic Azad University

² Technical & Vocational University, Yazd Faculty of Engineering, Civil Engineering

³ Architectural Engineering, Construction Engineering Organization of Yazd
yavari_nasab@yahoo.com

Abstract: Earthquake phenomena and its occurrence would be considered as natural and dynamic disaster in the earth. Earthquake prediction is one of the valuable scientific challenges that if the results of research being successful, sustainable development would be achieved. In this paper, the earthquakes occurred during 2006 to 2009 as the time when the various definitions, day, month and by statistical analysis of recorded earthquakes in Yazd province in Iran, the higher frequency would be considered at a time.

[Seyed Ali Almodarresi, Kazem Yavari Nasab, Elahe Alsadat Mirkhalili. **Statistical Analysis of Earthquakes in Iran - Yazd Province in the years 2006 to 2009**. *Researcher* 2013;5(11):59-67]. (ISSN: 1553-9865). <http://www.sciencepub.net/researcher>. 10

Keywords: Earthquake, Iran, Yazd, magnitude of earthquake

Introduction

Earthquake shaking ground and the movement is due to the release of energy caused by the rapid breakdown of the faults in the Earth's crust occurs in a short time. The earthquake is one of the most terrifying natural phenomena. [1] Given the progress that has been made in the field of science, the forces that cause earthquakes, scientists have been able to identify. [2] But have not found a way to predict earthquakes, so people are not surprised when the earthquake struck. [3]

Generally the word earthquake is the vibration of any kind, either natural or artificial vibration by man, is creating waves vibrate. [4]

Earthquakes may lead to disease; loss of personnel, loss of life, damage to property, road and bridge damage, and collapse (or cause to fall in the future) is building. [5] The earthquake also volcanic eruptions, which cause further problems are created, for example, significant damage to the goods, as in so-called "non-summer" occurred (1816). [6]

Necessary seismic risk assessment is the topic of today's crisis management has become a major concern. [7] In order to determine the likelihood of future seismic activity, geologists and scientists who study rocks to determine if the rock appears "pressed" approaches to the study of faults in a region of the elapsed time for the enough pressure as a technique to predict earthquakes by faulting. [8] Measurements based on the amount of strain energy stored in the fault each year, time passed since the last great earthquake, and the energy and power of the last earthquake are presented. [3] Seismologists usually mathematical and probabilistic models are used to forecast earthquakes. [9]

The country also attempts to analyze seismic areas using various formulas and mathematical models, such as the fractal model. [10]

All these facts allow scientists to determine the amount of pressure required to cause an earthquake fault. [11] Although this approach is useful, but it had only been implemented on California's San Andreas Fault. Nowadays ways to protect and prepare possible sites of earthquakes from severe damage exists such as earthquake engineering, preparedness against earthquake, seismic safety family establish seismic equipment (including accessories, materials and methods specific), reducing the earthquake, and earthquake prediction. [12]

Recorded earthquake to earthquake detecting device called Accelerometer uses the data from the device, or as a series of numbers, indicating that the acceleration (acceleration - time) are classified, or merely a numbers represent the acceleration of the earth. [13] In the second case, the data are at the interval of a few this data. [14] Data for earthquakes in Iran Building and Housing Research Center can be downloaded from the site. [15]

Magnitude of earthquake was recorded first by Rikter and using his machine was designed by Wood and Anderson's biggest surface at a distance of 100 km from the center of the wavelength range recorded in the device measuring the seismograph of the number logarithm into the base. [16] When we say the magnitude of an earthquake is the logarithm of the largest wavelength range from the standard seismograph by Wood and Anderson seismograph at a distance of 100 km from the center of surfaces has been developed. [17] Other measures in the event that the ML depth is shallow earthquakes and the

seismograph is located close to the center of the surface, the magnitude of an earthquake is known as the local magnitude [18] in the case of small earthquakes scale surface wave magnitude M_s is the depth scale can be expressed in appropriate magnitude. [19] M_b is earthquake magnitude scale internal waves. [20] 3 smaller earthquakes often cause serious damage to tangible and 7 times greater than themselves. [21]

The various parameters which have to be more than 30 cases have been investigated for predicting earthquakes. For example, you can change the gravitational potential of the Earth's crust named Altitude changes by the change in density is observed Microgul precision instruments [22]. And behavioral changes in animals, especially dogs, can be caused by electromagnetic waves caused by earthquakes noted [23]. In addition to the previous cases, one of radon gas emissions to 10 days before an earthquake [24], the thermal diffusivity of the soil around the fault [25], fluctuating water levels, the change in electrical resistance and the accumulation of stress in the crust land [26] as mentioned parameters that can predict the situation before the earthquake. But today, the precursor to meteorology and atmospheric widely in earthquake prediction, are studied. For example, researchers found that the variation in the earthquake, which could lead to changes in heat flow [27] and columns of water vapor in the atmosphere to form [28] or changes in the ionosphere, causing electromagnetic [29] and may lead to precipitation [30]. In terms of climatic phenomena associated with earthquakes and earthquake prediction of meteorological parameters can include research scientists from Russia in the nineties [31].

History:

The earthquake prediction, forecasting the location, magnitude and predict when an earthquake is predicted. For many people, the concept of prediction, earthquake prediction is the only means. [32].

The literal meaning of Prediction and Forecast to predict and are oriented to predict the experimental proof that the form forecasting and Foresight meaning is normative. In this paper, to avoid discrepancies in the sense of the word mellow Prediction is used. [33] Numerous attempts to obtain physical clues for prediction earthquake took place. In 1975, the Chinese were able to grab the earthquake increased seismic (pre-earthquake) and domestic unrest, and predicted a large area to evacuate. [34] Any parameter changes that occur before the earthquake, so that earthquakes can be predicted by examining the changes before it is indicator. Since the multiple markers that are known to be over 30. [35]

These markers include crusted deformation, changes in sea level, tilt, and shell, and geologic precursor magnetic field, the change in the gravitational field, before the earthquake, Rodney emissions, changes in flow and elevation groundwater, animal behavior and etc. [21]

The main problem in using the check, the need for continuous recording and evaluating changes is obtained. For example, groundwater levels fluctuate naturally in different seasons, but continued to record and several years of fluctuating groundwater levels in the seasonal averages of certain abnormal changes that comes in a detectable. [36] On the other hand, due to the involvement of other factors in the parameters, it is necessary to simultaneously consider several factors prior to show. [11]

Gathering information on earthquake and ancient earthquake recorded in one region or belonging to a long active fault using seismology, and statistical analysis, the frequency of events with magnitude earthquake gives special. [37]

Statistical analysis of earthquake risk area in a "return" to the earthquake with a certain magnitude is notified. If a magnitude 7 earthquake return period is the one hundred years, which means an earthquake of magnitude 7 on the Richter scale in the region may occur. Thus, as the time passes by the previous damaging earthquake, further increases the likelihood of damaging earthquakes. [38] Since the beginning of the eighteenth century, more than three million people have lost their lives in the earthquake. [36]

About three million earthquakes occur in the world each year, or roughly eight thousand earthquakes or an earthquake every day on average 10 to 70 s that it is detrimental to 75, these events per year on average 10 leaving thousands dead. [39]

Today, many more earthquakes than previously published, but this is not due to improved measurement tools to increase the number of earthquakes. USGS estimates that in 1900 had an average of 18 major earthquakes (magnitude 0.7 - 9.7) and a very large earthquake (magnitude 0.8 or more) per year exist, and a ratio of approximately has been fixed. In recent years, the number of major earthquakes per year was reduced. [41]

Materials and Methods:

Iran means land of the Aryans with the Islamic Republic of Iran, a country in Southwest Asia and the Middle East is 1648195 km². Yazd is one of the 30 provinces of in central Iran. The city between the mountains and Shirkooh and Kharanegh and the doors have been wide. [12]

Yazd province lies between Lengths of in central geographical 52° 48' and 56° 23' east and also

36° 29' and 33° 22' of north. The province has an area of 73467 square kilometers. Its capital city is 1230 meters above sea level and the height of the mountain is located Shirkooh and Khranq and wide doors. Synoptic weather stations in the province over a period of thirty years (1966 - 1995) are as follows:

Temperature: Absolute maximum: 45.6, absolute minimum: -12 and average temperature: 18.9

Precipitation: Average annual rainfall: 64 mm, maximum rainfall in one day: 48 mm

The average relative humidity: 25-44%, the average frost days is 60

The total population of the province is 750769, of which 385,936 are males and 364,833 females. [11]

The oldest occurred Instrument Earthquake in Yazd Province on 9/2/1931 at 3:28:23 hours recorded. The magnitude scale internal waves on 4.5 scales. Instrumental earthquake occurred in Yazd Province

on 9/16/1978 at 15:35:56 am registered. The surface wave magnitude scale 7.4, waves to the inner 6.4 is recorded by the International Seismological Centre - UK (ISC). [34]

Major faults and seismic Bahabad, Kuhbanan and Nayband in the East, and the great fault Dehshir in the west several active faults in the area of small and large, expressive of experience and destructive earthquakes in the past and possible future. Using Statistic Reports of earthquakes information, relative earthquakes in Yazd province of Iran was 2.7 percent. [17]

This paper has about 3,000 earthquakes recorded in Geosciences related to Yazd province is analyzed and results are expressed as follows:

1: Chart 1 shows relative earthquake magnitude scale internal waves in 2006 and 2007 and between 2008 and 2009 at intervals of 1 is assigned.

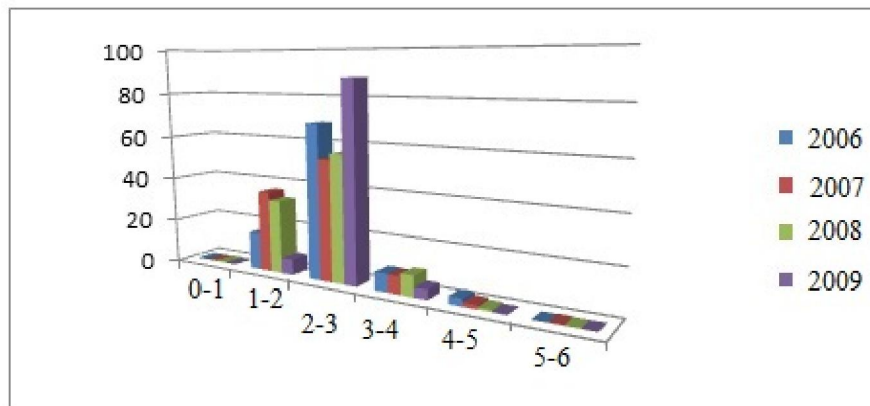


Chart 1 - Relative earthquake magnitude scale internal waves in 2006 and 2007 and between 2008 and 2009

2: In Chart 2, the relative rate of earthquakes in 2006 and 2007, 2008 and 2009 is expressed in terms of days of occurrence.

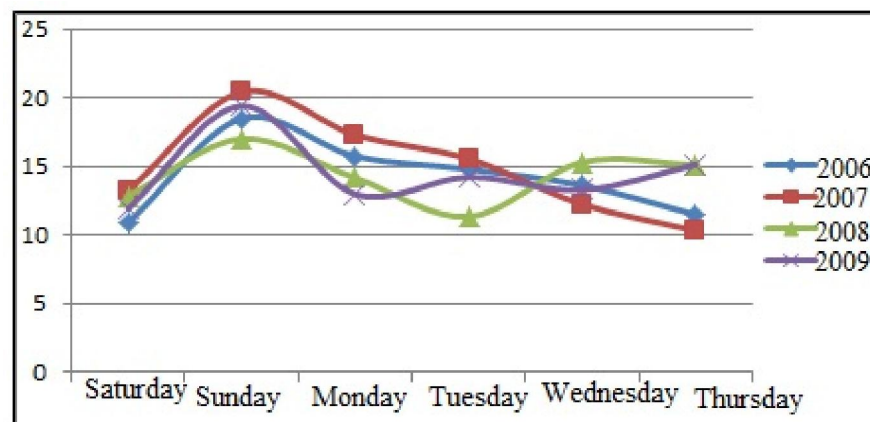


Chart 2 - Relative earthquakes of 2006 and 2007 and the years 2008 and 2009 in terms of the day of occurrence

3: In Chart 3 the relative amount of earthquakes in 2006 and 2007, 2008 and 2009 is expressed in terms of months.

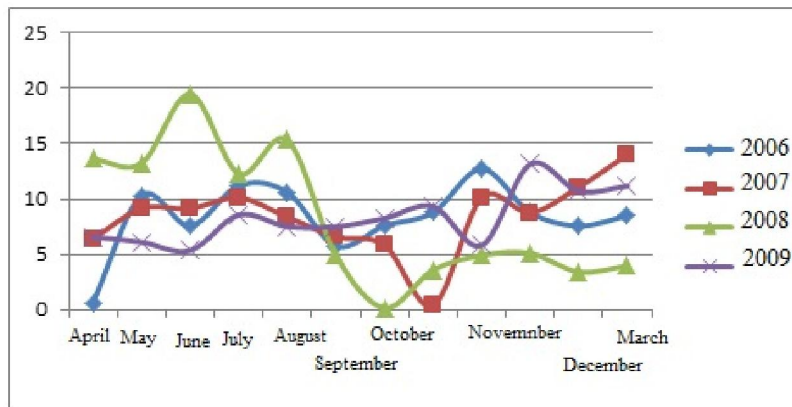


Chart 3 - Relative earthquakes of 2006 and 2007 and the years 2008 and 2009 in terms of months

4: In Chart 4, the relative rate of earthquakes in 2006 and 2007, 2008 and 2009 based on the 3-hour period of time is discussed.

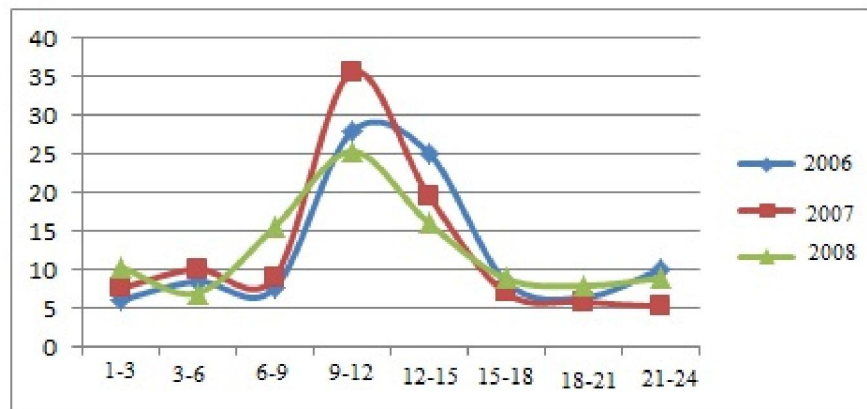


Chart 4 - Relative earthquakes of 2006 and 2007 and the years 2008 and 2009 based on time intervals of 3 hours

5: In Chart 5 the relative rate of earthquakes in 2006 and 2007, 2008 and 2009 is explained by the season occurrence.

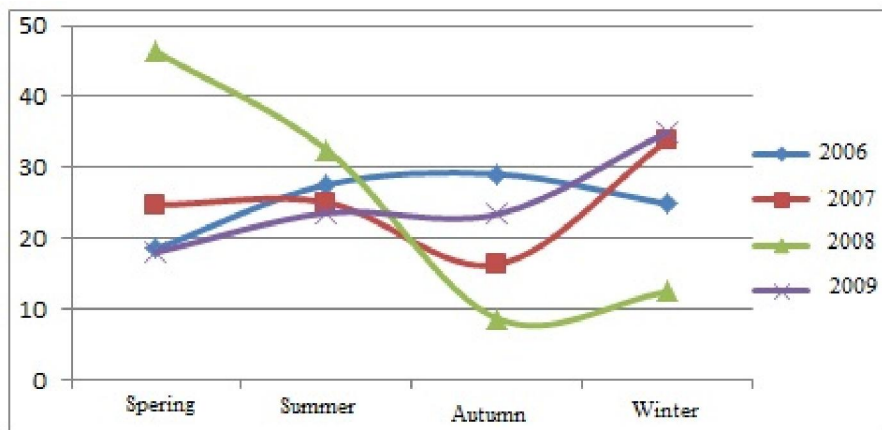


Chart 5 – year relative earthquakes of 2006 and 2007, 2008 and 2009 based on the season occurrence

6: In Chart 6, relative earthquake in years 2006 and 2007, 2008 and 2009 based on days of the week on Saturday and Sunday of the first week, Monday and Tuesday and Wednesday in the middle of the week, Thursday and Friday last week contracts have been expressed.

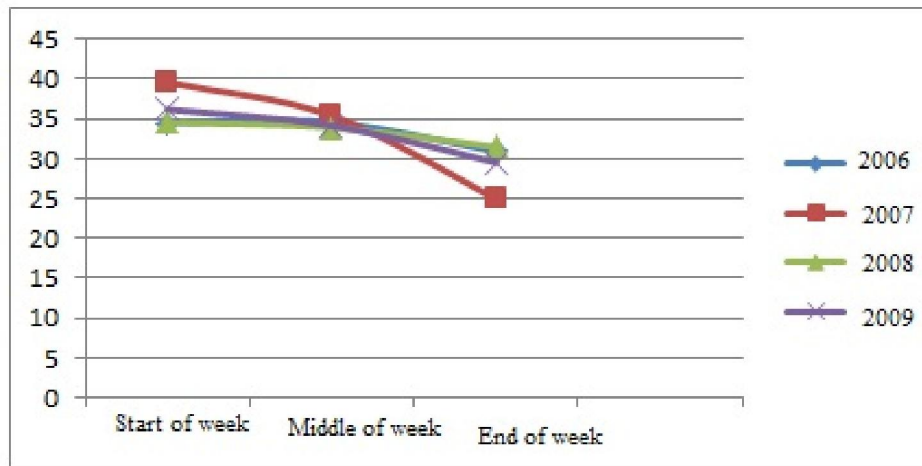


Chart 6 – Relative earthquakes of 2006 and 2007 and the years 2008 and 2009 based on the first, middle and last week

7: In Chart 7 the relative prevalence of earthquakes in 2006 and 2007, 2008 and 2009, according to the 6-12 hours of the morning, the afternoon and evening 12-18, 18-24 pm the night, 0-6 on the night we discussed.

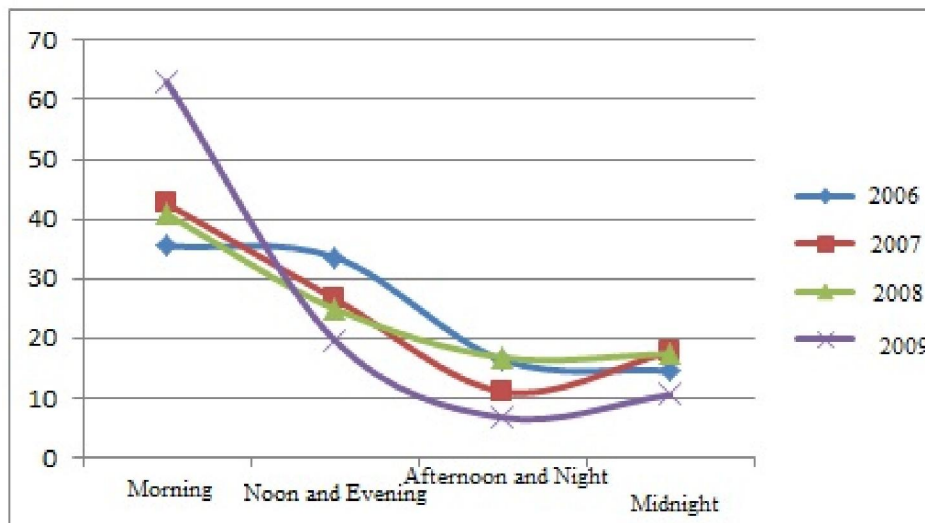


Chart 7 - Relative earthquakes of 2006 and 2007 and the years 2008 and 2009, according to Dawn, evening, night, midnight

Analysis of results:

According to Chart 4, the relative rate of earthquakes in 2006 and 2007, 2008 and 2009 depending on the time of occurrence of a 3-hour intervals; Maximum earthquake is seen in 9-12 hours based on hourly data for the period analyzed, and regardless of the particular year and the total is expressed:

8: In Chart 8, the relative rate of occurrence of earthquakes in the years 2006 to 2009 per month which has been occurring in 9-12 hours.



Chart 8 - Relative earthquake of 9-12 hours per month of the years 2006 to 2009

9: In Chart 9, months of 2006 relative to 2009 based on the occurrence of earthquakes that occurred is expressed in 9-12 hours.

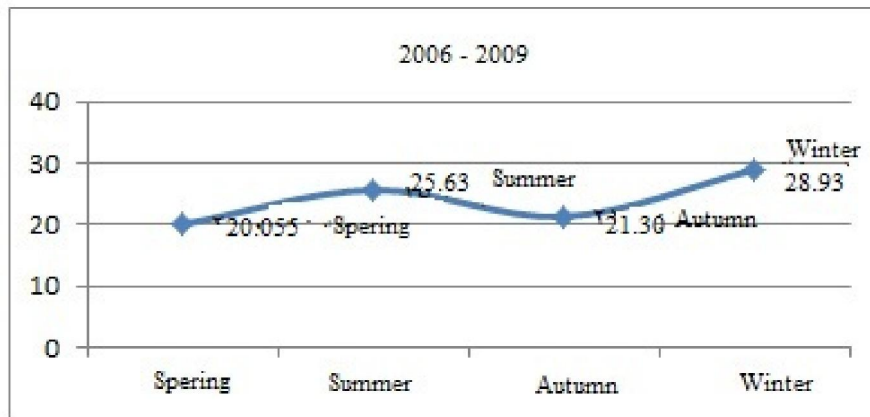


Chart 9 - Relative earthquake 9-12 hours depending on the season of the year 2006 to 2009

10: In Chart 10, the relative rate of occurrence of earthquakes in the years 2006 to 2009 per day that occurred is expressed in 9-12 hours.

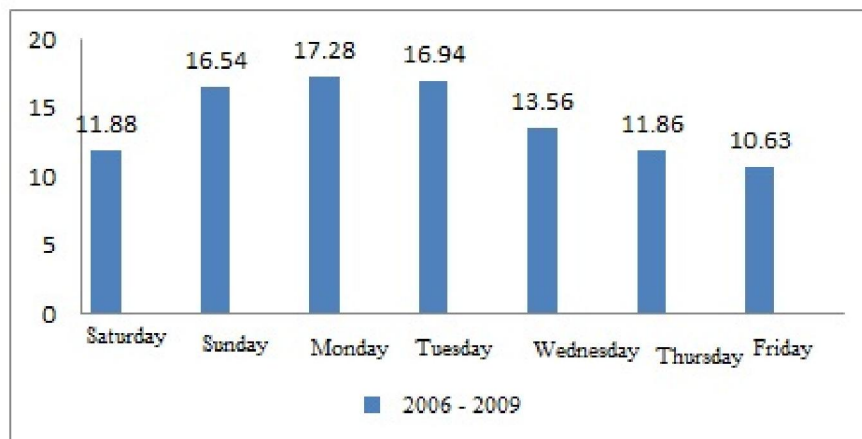


Chart 10 - Relative earthquake time of day 9-12 years 2006 to 2009 based on days of occurrence

11: In Chart 11, earthquakes since 2006 relative to 2009 based on the weekdays, Saturday and Sunday of the first week, Monday and Tuesday and Wednesday in the middle of the week, Thursday and Friday last week, we have a contract in 9-12 hours expression has occurred.

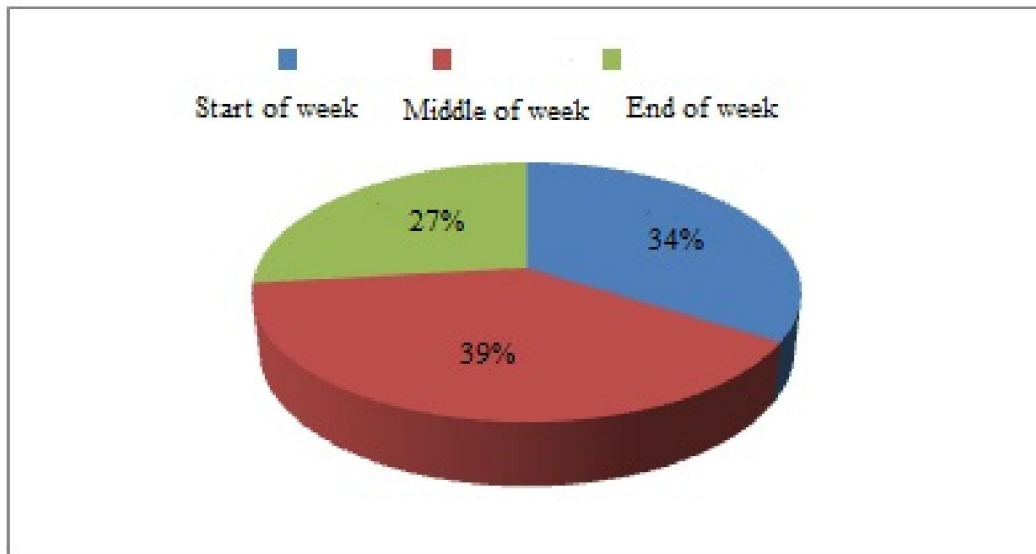


Chart 11 - Relative earthquake 9-12 years of 2006 to 2009 hours, depending on beginning, middle and end of the week

Conclusion:

Statistical analysis was performed using the following conclusions can be stated:

- 1 - Using the Chart 1 is a maximal minor earthquake in Yazd province.
- 2 - With regard to the results of Chart 2 and the sum of the years 2006 to 2009 are presented in Chart 12, the maximum and minimum earthquake occurred on Sunday is the Sabbath. Using the data from Chart 10 that the earthquakes that occurred in 9-12 hours are the minimum and maximum earthquake on Friday Monday is considered.

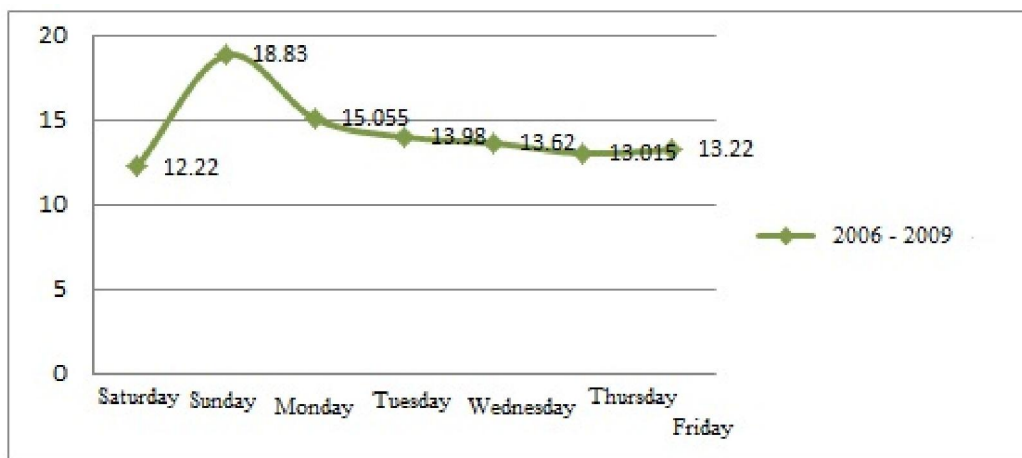


Chart 12 - Earthquake in the year 2006 relative to 2009 per day of occurrence

3 - Using Chart 13, the relative rate of earthquakes in the years 2006 to 2009 suggests; minimum and maximum earthquake at the weekend in the first week. Using the data from Chart 11 that the earthquakes that occurred in 9-12 hours the minimum and maximum over the weekend earthquake in the middle of the week.

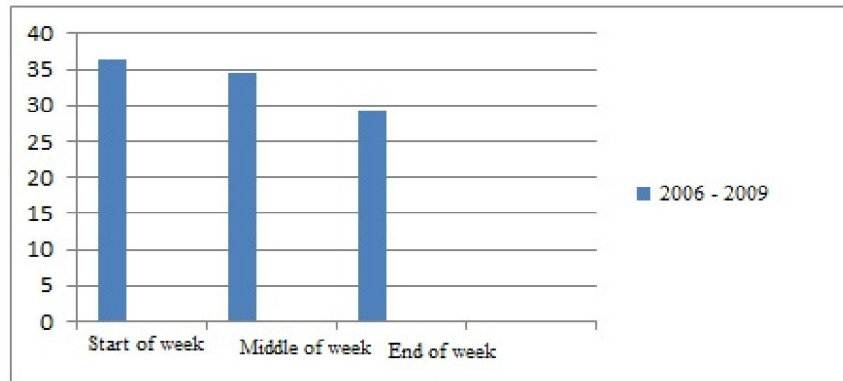


Chart 13 - The earthquake of the year 2006 relative to 2009 in terms of beginning, middle and end of the week

4- Using Chart 14, which indicates the years 2006 to 2009, is a minimum hull earthquake earthquakes occurred in autumn and looking at Chart 9, most earthquakes are occurring in the winter, 9-12 hour.

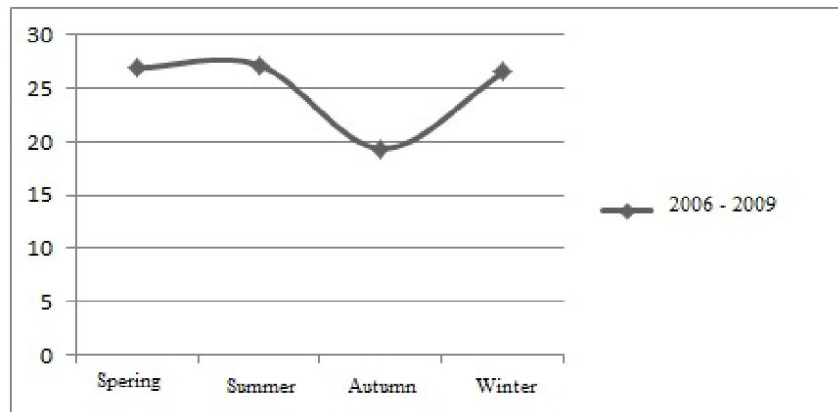


Chart 14 - Relative occurrence of earthquakes during 2006 to 2009 according to season

5- With regard to Chart 4, the relative earthquakes during 2006 and 2007, 2008 and 2009 depending on the time of occurrence in the range of 3 hours speech and Chart 15, the relative helpless in all the years of 2006 to 2009 suggests the stated that the maximum earthquake in 9-12 hours.

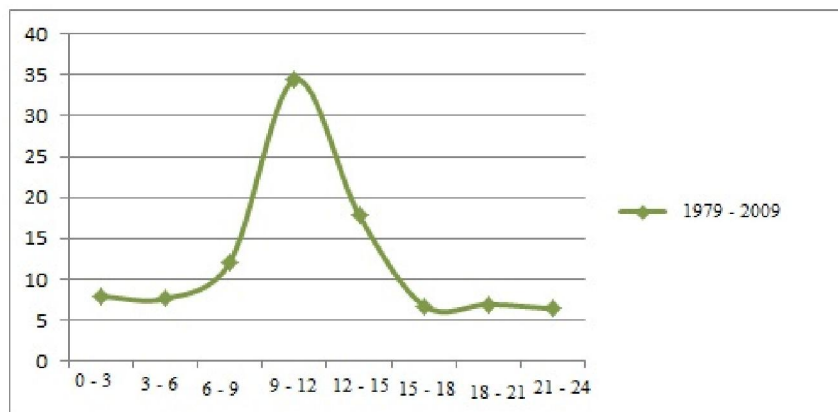


Chart 15 - Relative earthquakes occurring in the years 2006 to 2009 according to the time interval of 3 hours

References:

- 1- Earthquake Engineering: Principles and Applications - Moghaddam, Hassan - Frahang - 2006
- 2- What you need to know the earthquake - a phenomenon born Farrokh Parsi Fatemi - Institute of Seismology and Earthquake Engineering
- 3- Principles of Engineering - Khowsrow. - Jahad Institute Publications
- 4-Structural Dynamics and Earthquake Engineering - Magrdchiyan, Arc – Rouzbahan
- 5- Buildings earthquake engineers - Tabashpour, Mohammad Reza - Fadak Isatis
- 6- Engineers earthquake - Adeli, Hojjatollah- Dehkoda
- 7- JICA, the Japan International Cooperation Agency (2000), classified in sub-zone of an earthquake in Tehran, Earthquake and Environmental Research Center, Tehran, Chapter 2: 7
- 8- Principles of earthquake engineering - Alirezaei, M. and Shakib, H. – Sanei
- 9- Holliday, J.L., Rundle, J.B., Tiampo, K.F., Klein, W., Donnelan, A., (2006) Modification of the pattern informatics method for forecasting large earthquake events using complex eigenfactors. *Tectonophysics*, 413: 87–91.
- 10- Aghashahi, S., Khatib, M. (2006) Comparison of formula 2b fractal dimension of earthquakes in a seismic fault zone Zahedan (East of Iran), *Proceedings of the Eleventh Geological Society of Iran*, 3098-3090
- 11- Seismology - Tavakoli, meteorites - Publications of the New Message
- 12- Correction of major earthquakes and the traditional wavelet and compare the two methods, Ansari Vahidifard H.A.; Ansari A., Asadollah Nourzad - *Journal of Civil and Surveying Engineering* -2010
- 13- Earthquake, cities and faults – Hossein Negaresh
- 14- Statistical analysis of earthquakes and quarry blasts in the carpathian basin -new problems and facilitities- Márta MARÓTINÉ KISZELY- Geodetic and Geophysical Research Institute of the Hungarian Academy of Sciences
- 15- <http://www.fa.wikipedia.org>
- 16- <http://www.howstuffworks.com>
- 17-<http://www.ngdir.ir>
- 18- <http://www.iiees.ac.ir>
- 19- <http://hamshahrionline.ir>
- 20- <http://www.hupaa.com>
- 21- <http://irsc.ut.ac.ir>
- 22- Samimi, S., Naimi, M. (2007) study of gravity changes as an indicator of the earthquake, *Proceedings of the First International Conference on earthquake precursor Center, Institute of Geophysics earthquake precursor*: 159-153
- 23- Bokaeae, B, Al-Davood, J. (2007) The use of behavioral changes in dogs caused by electromagnetic waves in earthquake prediction, *earthquake precursor Conference Proceedings, Institute of Geophysics earthquake precursor studies*: 48-36
- 24- Rahimi, M.; Quraish, A., Ranjbar, H.; Negarestani, AS (2007) Continuous monitoring of radon in groundwater network of deep wells, Valiasr Rafsanjan to evaluate radon marker in the event of earthquakes, *Proc. earthquake precursor Conference Center, Geophysical Institute of earthquake precursor*: 102-96
- 25- Rezapour, N., AliAkbari, A., Fattahi, M. (2007) Relationship between climatic parameters of earthquakes in the Alborz mountain range and the possibility of using it as a pre-cursor, *Proceedings of the First International Conference on earthquake precursor Center, Institute of Geophysics earthquake precursor* : 118-110
- 26- Yazdani, M., Kalantari, D. (2007) The stress field in the crust as the main precursor of earthquakes, *earthquake precursor Proceedings of the First International Conference Center, Geophysical Institute of earthquake precursor*: 304-298.
- 27- Singh, R.P., Bhoi, S., Sahoo, A.K., (2001) Significant changes in ocean parameters after the Gujarat earthquake. *Curr. Sci.* 80 (11): 1376-1377.
- 28- Dey, S., Sarkar, S., Singh, R.P., (2004) Anomalous changes in column water vapor after Gujarat earthquake. *Advances in Space Research*, No.33: 274-278.
- 29- Shvets, A.V., Hayakawa, M., Molchanov, O.A. Ando, Y., (2004) A study of ionospheric response to regional seismic activity by VLF radio sounding. *Physics and Chemistry of the Earth*, No.29, 627-637.
- 30- Sassa, K., Fukuoka, H., Sekiguchi, T., Moriwaki, H., Hirota, O., (2005), Achievements of aerial prediction of earthquake and rain induced rapid and long-traveling flow phenomena (APERITIF) project: *Annuals of Disas. Prev. Res. Inst., Kyoto Univ.*, No. 48 C.
- 31- Morozova, L.I., (1997) Dynamics of cloudy anomalies above fracture regions during natural and anthropogenically caused seismic activities. *Fizika Zemli*, No. 9: 94–96.
- 32- Harrington, D., Shou, Z.H., (2004) *Bam Earthquake Prediction and Space Technology, Earthquake Prediction Center, New York, USA*: 39-63.
- 33- Earthquake with an estimated rate of cloud model to predict a correlation between seismic events in the fourth quarter of 2009 - *Environmental Hazards* - (1): 126-111 (1391) – Berahmand, A.; Mansouri Daneshvar, P.

9/2/2013