IJBPAS, September, 2014, 3(9): 2160-2169

ISSN: 2277–4998

International Journal of Biology, Pharmacy and Allied Sciences (IJBPAS)

'A Bridge Between Laboratory and Reader'

www.ijbpas.com

SYNOPTIC AND STATISTICAL ANALYSIS OF DRY YEAR IN THE CITY OF PARS ABAD BY EMPHASIZING ON WATER RESOURCES

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ABSTRACT

Climate variability is one of the main topics that have been discussed in most of scientific conventions. Although some of the climatology experts don't believe in climate change' they believe that the world has been involved in climate abnormalities. Temperature increase and rain decrease confirm the climate change, there for drought is taken in to account as a climate events. Statistical studies indicate that among all of the disasters that have affected human beings during recent decades, drought frequency losses of life and property and social effects are more than the other kinds of disaster in the past long time. Thus with respect to the importance of the subject, the present paper has studied the entity of drought in the city of Pars Abad, a northern city in Ardabil province placed in northwestern of Iran. Since the studied region is not only an important agricultural center in the province but in the country, so identifying drought behavior seems essential in this region. Along this and in order to study the dry and wet year situation in Pars Abad we have used SPI index and synoptic maps. The results showed that the most severe dry year has occurred in 2000 with -2.2 drought coefficient. Thy results from another study reported a 4-year long drought (2005 -2008) with different rates. Also studying synoptic maps (ground level and 500 mb) it was identified that pressure patterns and atmosphere systems are associated with the happening of dry year and wet year. So in the course of reducing and preventing dry year and confronting the possibility of bioenvironmental crisis including decreasing water resources, more precise planning are needed.

Keyword: SPI Index, Synoptic Maps, Dry Year, Pressure Patterns, Pars Abad

INTRODUCTION

Weather studies in the field of disasters and atmosphere have been taken under consideration since many times ago. Dry year is a climate crisis and occurs in a region due to unusual rain reduction, though its effects may differ from an area to another one. Iran in an arid and semi-arid country because of placing in dry belt of the earth and due to vicinity with high-pressure tropics and has led to severe dry years in many years. In recent years also dry year has resulted in many losses so that in 2000 and 2001 this has led to 3.5 and 2.6 milliard dollar, respectively. Ardabil province, especially pars Abad, regarding high agricultural potentials has not been deprived of climate disasters such as story, flood, drought, frigid and it faces major losses in its agricultural crops, garden products and stockbreeding activities every year. Since the least change in rain and temperature may lead to an irretrievable loss on economic system, thus weather predictions become necessary to be used in underlying planning of Iran in relation to climate and atmosphere disasters. Since we are faced with an increase in climate abnormalities in recent years including an increase in temperature, evaporation and transpiration, rain reduction, rain axis deviation chronologically and population growing, these factors aggravate the dry year and drought.

Concepts and Definitions of Dry Year

Dry year is an inevitable environment entity which has alternatively occurred in geographical environments also will happen in the future. Therefore, it is possible to reduce its losses just through identifying and planning in advance. Dry year is a natural event and slow entity that many believe it as a complex mechanism and its whole characteristic is less known than other kinds of disasters. Dry year affects first of all on agriculture and natural resources due to direct relation and dependence with the humidity from rain then its effects are appeared in ground and underground water and at last affects other social systems, too. Dry year effects are divided into two groups: direct and indirect. Its direct affects are product deficiency on agriculture farms, ranges and jungles, fire expansions, water discharge from underground and surface waters, mortality increase in stock and wild life. Its indirect effects which are more effective than its direct effects are low income with farmers, low tax income with governments, high expenses of weeds and drinking water, fine increasing emigration and so on. Dry year is a phenomenon that happens in different regions of the world due to a decrease in rain rate every many

years and if sustainable agriculture cannot resist against it, famine will be resulted Both rainfall decrease and temperature increase or each separately underlie dry year.

Dry year prediction is the first strategy to confront and reduce the losses from dry year. Thus studying indices determining dry year can be a great demand for this importance. Different aspects of dry year are: meteorology, hydrological, agriculture and socioeconomic. The trend of dry year forming is such in which there are four separable stages. First, by atmosphere variations such as rainfall decrease, temperature increase and evaporation and transpiration raise lead to meteorology dry year. Increasing to water demand occurs due to meteorology dry year, decreasing run off and discharge of rivers, decreasing the infiltrated water in soil and discharge of stored water in the ground, decreasing the stored waters at the bans. Plant stresses begin in this stage due to lack of needed water supply for plants, ranges and woods.

These stresses are subject to severity and durability of dry year. In the fourth stage the effects of dry year appear as environment social, economic and bioenvironmental effects. It is in this stage that all people become aware of dry year occurrence, while this stage is the find stage that devastating effects of dry year are obvious (of course its occurrence may has already been predicted by meteorologists and environment expects)In this stage its effects are identified for more groups. Many studies have been conducted in the field of predicting dry year using quantitative methods in all around the world. Due to different variables involved directly or indirectly in dry year occurrence, defining this word is difficult, that's why no general and comprehensive definition has been presented yet.

[1] introduced a new index to study about dry years and big floods; this index exclusively uses rainfall data. **[3]** showed that there were more than 150 different definitions of dry year in the world by early 1980s. **[3]** developed standardized rain index for the definition and protection dry year and used standardized rain index to protect dry year across Coloroda State by cooperation his colleagues in1994. Also several studies have been performed in Iran. **[4]** in his studies on normal trend of dry and wet years in Iran, has proposed the index of yearly rain scale and applied it in a network consisting from 1200 stations separating by Iran, watershed.

The minimum index value of different stations in the research equals -2.47 and the maximum one is 2.78. **[5, 6]**, first, identified the periods of dry and wet years using statistical methods, then determined synoptic systems of dry and wet periods based on daily and monthly scale, and

finally studied atmosphere pattern categories leading to dry and wet years. He used standard score index (z) in his studies to evaluate and protect Iran's dry years.

Geographic Location of the Studied Region

The synoptic station if Pars Abad has been located in 47 degrees and 46 minutes longitude and 39 degrees and 36 minutes latitude in geographical coordinate and is approximately 73 m higher than sea level. The city has placed in north of Iran in political divisions and is bounded to Azerbaijan country in east and north and in west to Aslandooz town and in south to Germi city **(Figure 1)**.

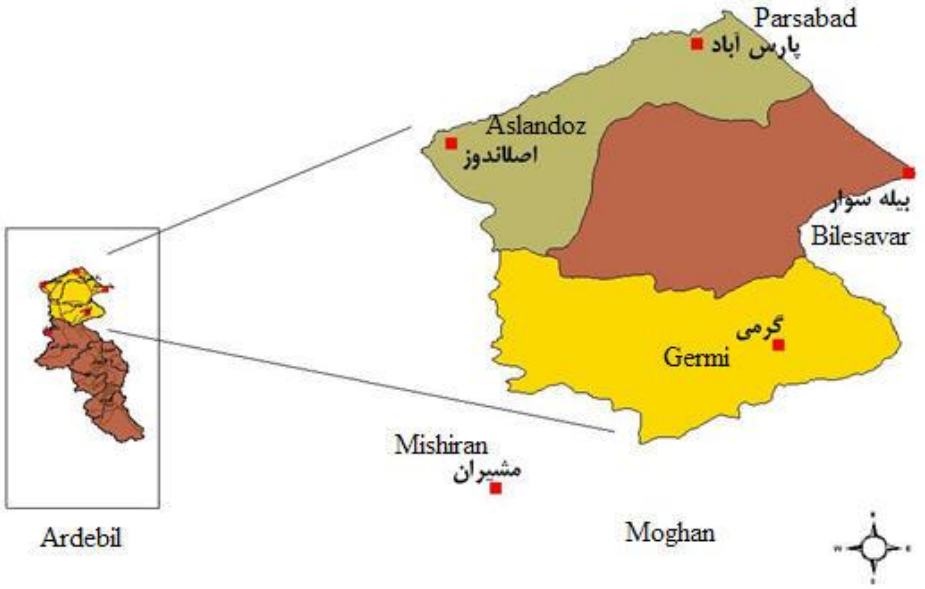

Figure 1: Studied Region

MATERIAL AND METHODS

A 25-year statistics of synoptic station has been used in this study to analyze the dry year of Pars Abad city since 1986 to 2010. First, statistical data were controlled by validating test rainfall and temperature was analyzed by means of Excel and SPSS software. And the meteorological parameters of studied region are given in the **Table 1**.

Monthly and Yearly Rainfall Analysis in Studied Region

Rainfall values showed that the maximum rainfall occurred in Ordibehesht with 35.5mm total mean rain value and the minimum was in Mordad with 6.5mm. The daily mean value of station temperature was calculated as 15.2c Ambrotermic diagram was provided in order to discriminate the dry months from wet ones **(Figure 2)**. As shown in the figure, the figure, the dry months begin Khordad (last month of spring) and last to early Mehr (first month of fall).

Mean value of total annual rainfall in synoptic station of Pars Abad was calculated as 268.0mm. Maximum and minimum rainfall was in statistical periods of 1382 and 1379 with 386.5 and 110.9mm, respectively. The variation range of this station reaches to 275.6mm **(Figure 3)**.

Season Distribution, Standard Deviation and Coefficient of Rain Variation in Studied Region

Seasonal rain distribution in Pars Abad station is such that 34 Percent annual rain occurred in spring, 33% in fall, 20%in winter and 13% in summer **(Figure 4)**.

The variation coefficient of monthly rain is much more in hot seasons of the year than other months which indicate random and irregular rain during hot season of the year **(Table 2)**.

SPI was used for monthly and annual interval to determine dry and wet years of Pars Abad.

1) **SPI (standardized precipitation Index) in annual interval:**

   This index is calculable on the basis of rain probable for every time interval and is of great importance to offer preliminary warning to evaluate the severity and intensity of the dry year. In the rest of the research the annual rain value were inserted into SPI software, then occurred dry and wet years were identified during statistical period **(Table3)**.

   According to this index, the most severe dry year in Pars Abad station is in 2000 with -2.6 draught coefficients and wettest was in 2003 with 1.5 coefficients. **Figure 5** shows that two wet year's of 4 year (1989-1992) and (2001-2004) have occurred continuously and with different rate5 in this station and in other statistical years there. Was no order in dry year? As a whole it is said that the trend of wet year is of great order but the trend of dry years are highly irregular.

2) **SPI Rain in Monthly Time Interval**

   In relation to monthly analysis of dry year after applying statistical operations, at last SPI values were estimated for 300 months **(Table 4)**.

   What the above table indicates is that the most severe dry years were 2 cases in Aban, average of the most dry year has 7 cases in Bahman, and Mordad dented the most natural condition to itself with 22 cases. Figure6 shows the condition of the months in a year according to the percent.

3) **Synoptic Analysis of Dry Year in Aban, 2001**

Statistical studies showed that the most severe dry year during statistical period of Pars Abad station was in Aban, 2001 with-1.9 drought coefficient. Synoptic maps were adopted from NOAA internet site to analyze the pressure patterns of ground surface and middle level of atmosphere, and then the maps were interpreted. As **Figure 7** shows the map of ground surface in Aban, 2001, which was dominated by low-pressure system-Also its middle level is accompanied by low-high hod **(Figure 8)**. The outcome of above-mentioned systems was a severe dry year that had led the monthly total rain to be zero.

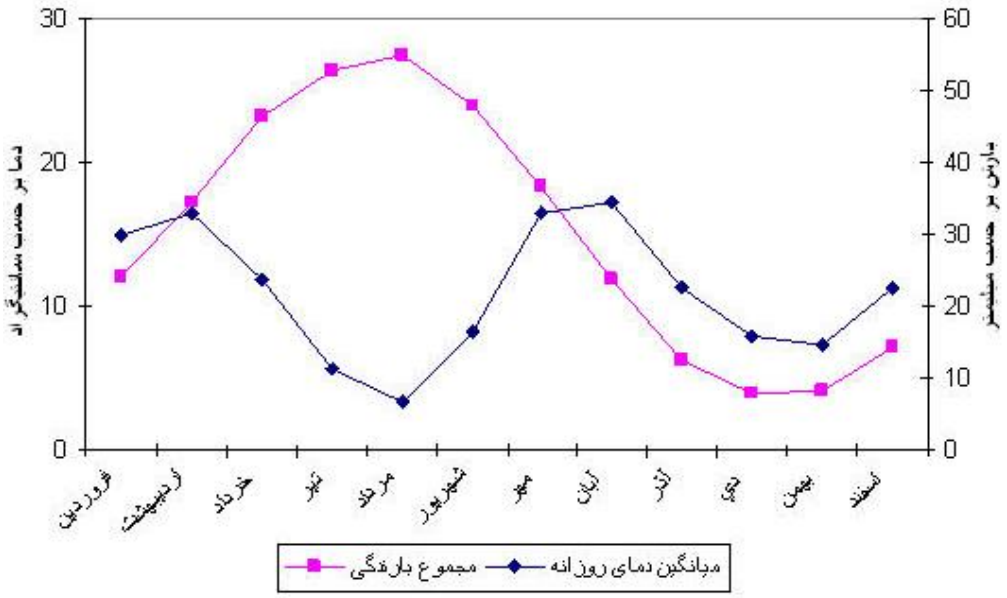

Figure 2: Ambrotermic Diagram of Synoptic Station in Pars Abad

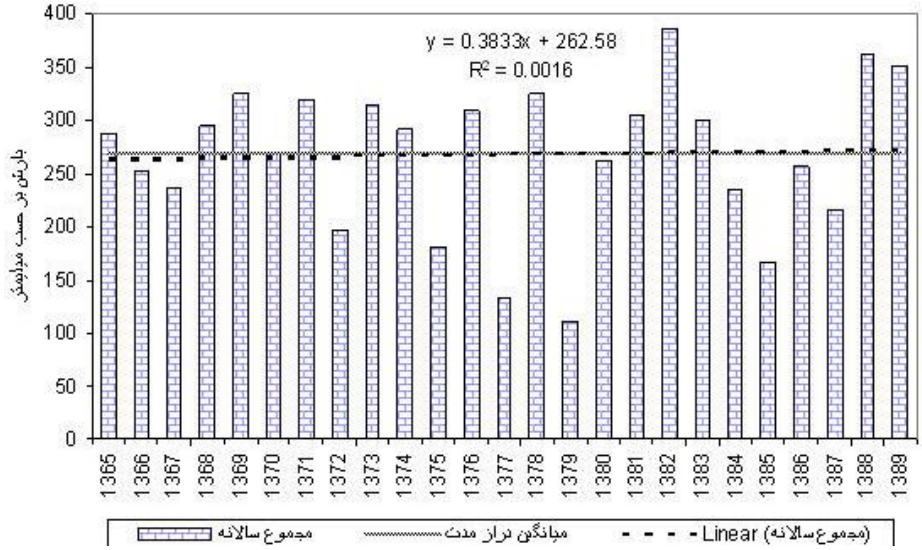

Figure 3: Diagram of Total Annually Rainfall in Synoptic Station in Pars Abad (1986-2010)

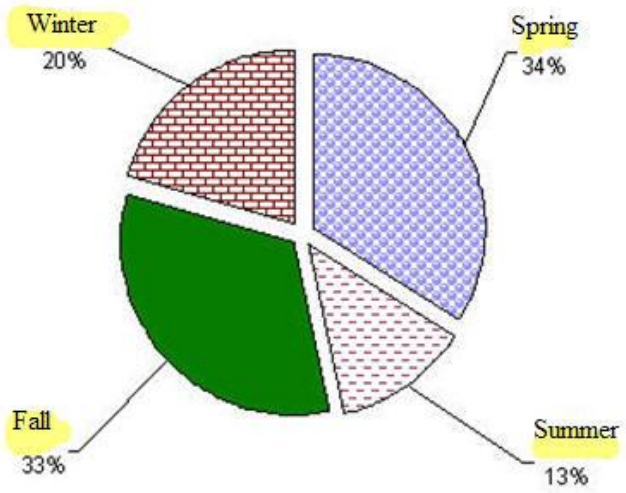

Figure 4: Seasonal Rain Distribution in the Synoptic Station of Pars Abad (1986-2010)

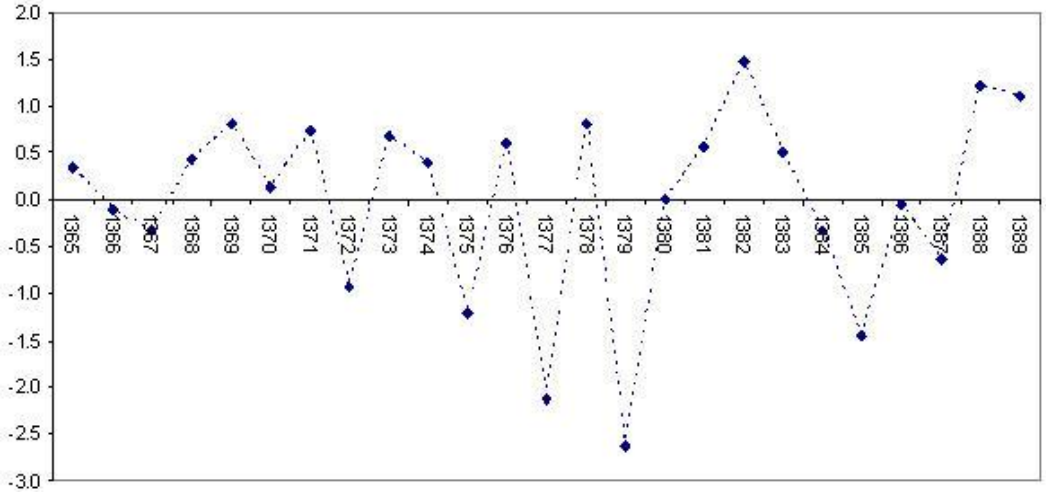

Figure 5: Values of Dry Year Coefficient of Synoptic Station in Pars Abad (1986-2010) According to SPI

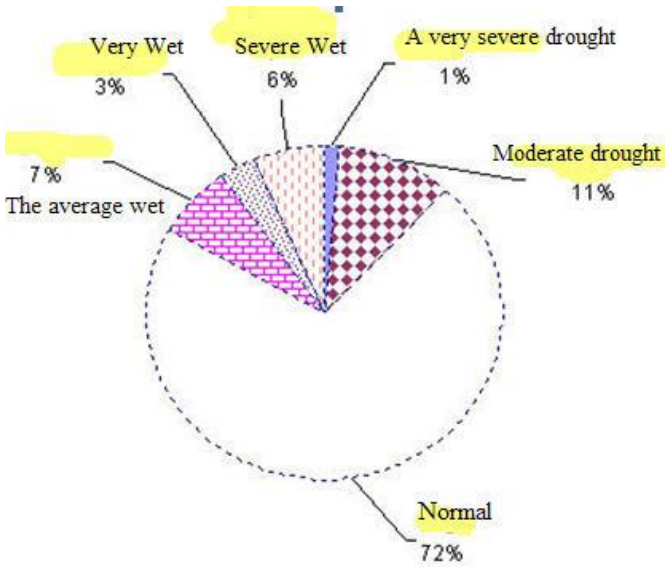

Figure 6: Dry Year Frequency According to the Percentage of Synoptic Station in Pars Abad

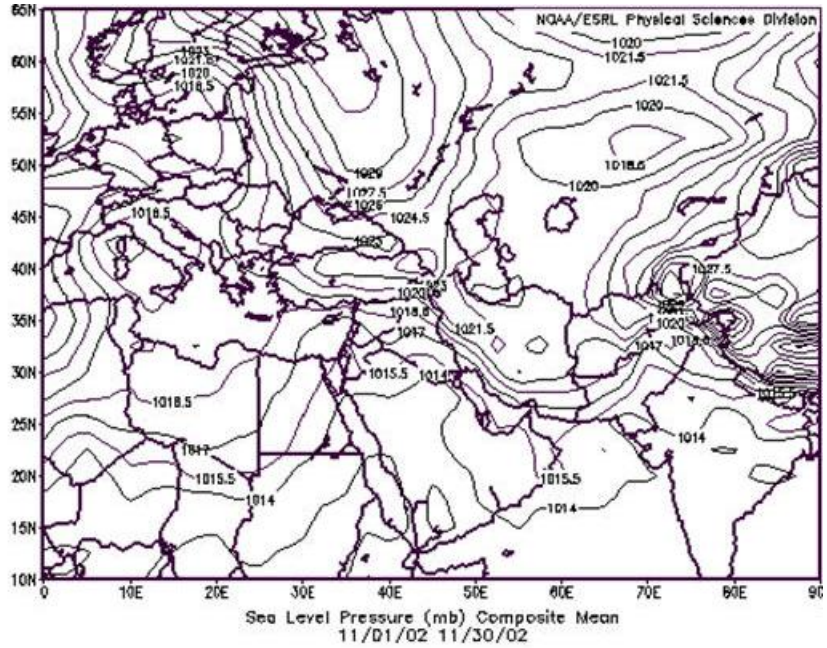

Figure 7: Maps the Surface Aban 2002

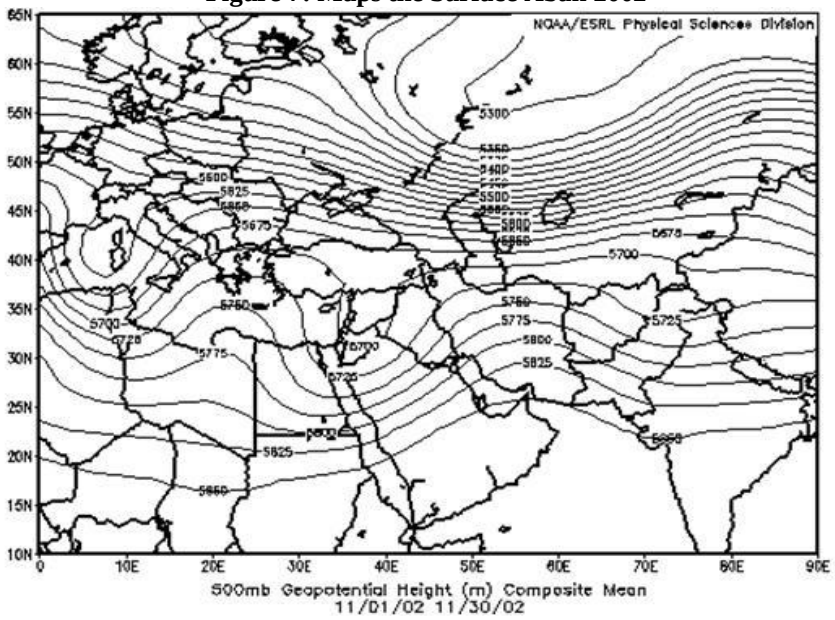

Figure 8: Map of 500 kPa Aban 2001

Table 1: Mean Value of Monthly Rainfall and Temperature of Synoptic Station in Pars Abad (1986-2010)

Month	Farvardin	Ordibehesht	Khordad	Tier	Mordad	Shahrivar
Rainfall	**31.4**	**35.5**	**23.5**	**11.6**	**6.5**	**17**
Average minimum temperatures	**6.4**	**11.4**	**16.4**	**19.9**	**21.1**	**18.3**
The mean maximum temperature	**17.6**	**22.8**	**30**	**33**	**33.8**	**29.7**
Average daily temperatures	**12**	**17.1**	**23.2**	**26.4**	**27.4**	**24**
Continued From Table 1						
htnoM	rheM	nabA	razA	yeD	namhaB	dnafsE
Rainfall	32.5	33.4	21.6	15.9	15.4	23.1
Average minimum temperatures	13.2	7.3	2.2	0	-0.4	2.3
The mean maximum temperature	23.4	16.3	10.5	8.7	9.1	12.4
Average daily temperatures	18.3	11.8	6.3	4.4	4.3	7.4

Table 2: The Values of Standard Deviation and Variation Coefficient of Monthly Rain in the Synoptic Station in Pars Abad

Month	Farvardin	Ordibehesht	Khordad	Tier	Mordad	Shahrivar
rain	31.4	35.5	23.5	11.6	6.5	17
standard deviation	23.4	24.7	20.2	11.8	8.9	20.6
variation coefficient	74.6	69.7	86.1	101.6	137	121.5

Continued From Table 2

Month	Mehr	Aban	Azar	Dey	Bahman	Esfand
rain	32.7	33.4	21.6	15.9	15.4	23.1
standard deviation	29.2	20.3	16	13.7	10.6	14.7
variation coefficient	89.3	60.7	73.8	86	69.2	63.6

Table 3: SPI of Pars Abad station in annual time interval

Index	A very severe drought	Severe drought	Moderate drought	normal	The average wet	Very Wet
Number of Years	2 year	1 year	1 year	18 year	2 year	1 year

Table 4: SPI Icon of Synoptic Station in Pars Abad During Monthly Statistical Period

Index/	Severe drought	Moderate drought	normal	The average wet	Very Wet	Severe Wet
Farvardin	-	5	16	-	2	2
Ordibehesht	-	4	16	3	-	2
Khordad	-	4	16	3	1	1
Tier	-	-	19	3	3	-
Mordad	1	-	22	-	-	2
Shahrivar	-	-	20	1	1	3
Mehr	-	4	18	1	1	1
Aban	2	3	16	2	1	1
Azar	-	3	18	2	-	2
Dey	-	-	21	1	-	3
Bahman	-	7	15	2	-	1
Esfand	1	2	17	3	1	1

DISCUSSION AND CONCLUSION

Using dry year indices is an important component to present premonition and gaining risk-management in the field of dry year. Severity and expanse of dry year are quantified by these indices. SPI icon was used to study the condition of dry year in Pars Abad during 25-year period (1986-2010). Conducted studies indicate occurring of weak to severe dry year. Another results of the research indicate that two period of wet year of 4-year (1986-1992) and (2001-2004) have occurred continuous and with different rates during statistical period in the station and gust a 4-year period of dry year has occurred (2005-2008) and in other statistical years there was no order in dry year and they begin suddenly, also analyzing synoptic maps confirm that occurred dry years are related with pressure patterns of ground surface and middle level of atmosphere systems. Since no prediction

of annual and monthly dry year has been successfully occurred, thus the officials of the province should be more careful in implementing water-management plans and its resources.

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