International Journal of Engineering Innovation & Research
Volume 3, Issue 4, ISSN: 2277 – 5668

Take a Meteorological Drought in the Sistan according to Statistics from 1972 to 2014 with Synoptic Station in Zabol using the Normal Index of Precipitation

Mohsen Rezaee
University of zabol, Iran
M59_rezaee@yahoo.com

Ali Rezvani Mahmuee
Bozorgmehr University of Ghayenat, Iran
arezvani@birjand.ac.ir

Samaneh Khaksefidi
University of zabol, Iran
samaneh112@yahoo.com

***Abstract* – Drought is one of the climate features in sense of shortage in water resources to the normal level of water that is likely to occur in all climate regions but with different characteristics from one region to another.**
The drought index, comprising a set of parameter such as: rainfall, snowfall, river stream, air mass, et al., is used to understanding the drought and its environmental influences in order to make clarification on this phenomenon.

In this study, we tried to analyze the meteorological drought by using the percent of normal rainfall and climate data gathered from synoptic stations in Zabol.

According to this study during the period from 1972 -2013, this region experienced a 5-year, weak dry spell during the period from 1985 to 1990 and a 10-year wet spell during the period from 1990 to 2000 according to the five-year moving average. In the beginning of 2000 dry period occurred again, but with more severity this time. Among diverse statistical functions examined for developmental embedding test and choosing the best distribution for mentioned synoptic station's precipitation data, Log-Pearson type 3 Distribution presented the best embedding graph and therefore drought severity calculated through this probability distribution function in reoccurrence interval.

***Keywords* – Zabol, Distribution, Drought, Percent of Normal, Moving Average, Precipitation, Water.**

I. INTRODUCTION

Drought is one of the natural disasters ¬ which causes lots of damages to human life and natural ecosystems. In deed drought is a lack of precipitation and rise in temperature may occur in any climatic region. Drought is often described as a creeping phenomenon that its spatio-temporal anticipation, unlike the other natural disasters, is very difficult. Also it should be noted that the drought is a stochastic, unpredictable phenomenon. But when it happens it will remain for a long time. [1]

In general, droughts are of three types: meteorological drought, hydrological drought and agricultural drought. Meteorological or climatic drought is basically due to the lack of precipitation, could lead to a hydrological and agricultural drought if it exists for a long time. [1, 2]

Iran has historically gone through hundreds of drought. Especially in recent decades have been met with a lot of damage caused by drought. Iran Drought characteristics show that in general any region of the country is not immune to this phenomenon, and the effects of this damaging than his natural position may experience. [3]

For quantitative analysis of drought, there is a clear indicator of wet anddry Periods, is essential for accurate determination. [4] In this regard, we can mention the following criteria.

Decile Index (DI)
Percent of Normal (PN)
Standardized Precipitation Index (SPI)
Environmental Performance Index (EPI)
Palmer Drought Severity Index (PDSI)
Bhalm and Mooley Drought Index (BMDI)
And more, [5, 6, 7, 8]

According to the indices used for studying and assessing this phenomenon it is observed that rain, given the availability of data, is thought to be the most important variable by majority of researchers who believed it played an indisputable role in all types of drought, namely: meteorological, hydrological, agricultural and socio-economic droughts. On the other hand due to the simplicity, comprehensiveness and creditability in the methods using percent of normal (PN) , presented by Willkie in 1994 A.D, to show mean deviation and predict interval reoccurrence of drought it is adopted to analyze this phenomenon in Zabol Basin in Sistan region, in Sistan and Baluchestan province, Iran. [5]

The average height of Zabol station is 489 Meters above the sea level. According to the climatic classification it is classified into places with hot and dry weather with the long-term average rainfall of 56 (mm)"millimeters (mm)", potential evaporation rate of 4616 (mm) and the average temperature 22.4 ° C"centigrade degree (° C)".

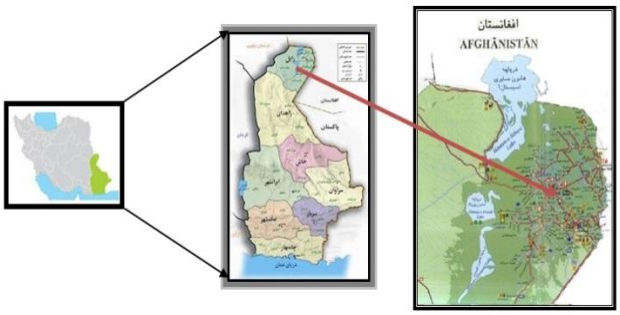

Fig.1. Location of the study area

II. MATERIALS AND METHODS

For the study of drought phenomenon in zabol Basin statistics gathered from Zabol synoptic station affiliated to meteorological organization. The study has conducted from 1972 to 2013 in a 41-year spell. The coordinates of the station is as follows in table.1.

Table 1: Coordinates of Zabol synoptic meteorological station

Station name	Zabol Synoptic meteorology
Longitude	61° 29′ E
Latitude	31° 02′ N
Height(m)	489

As it was mentioned the percent of normal is used in the study of drought in the Zabol basin. In this method the annual ratio of precipitation to the annual average of precipitation is used in percentage:

$$PN = \frac{P}{\overline{P}} \times 100 \quad (1)$$

In this equation:
PN is the percent of normal,
P is annual precipitation (mm),
$\overline{P}$ is the average of annual precipitation in the station (mm). [2]
Descriptive characteristics of the index is as follows,

Table 2: Drought severity based on annual rainfall to the average of annual rainfall

Drought severity	Percent of normal
Threshold	80
Weak	70-80
Average	55-70
Severe	40-55
Very severe	40>

As was stated before rainfall statistics gathered from Zabol synoptic meteorological station was used for investigating drought phenomenon in this research. Table 3 describes the annual rainfall statistics in the Zabol synoptic station during the water year (From September 23 to September 23 next year) period from 1972 to 2013.

Table 3: Statistics of annual rainfall in Zabol synoptic station (1972 - 2013)

row	Water year	Precipitation(mm)
1	1972-1973	26.6
2	1973-1974	72.5
3	1974-1975	104
4	1975-1976	81.8
5	1976-1977	55
6	1977-1978	43.8
7	1978-1979	33.9
8	1979-1980	75.4
9	1980-1981	122.7
10	1981-1982	47.2
11	1982-1983	53.9
12	1983-1984	32.4
13	1984-1985	64.4
14	1985-1986	68.2
15	1986-1987	16.9
16	1987-1988	68.5
17	1988-1989	11.8
18	1989-1990	72.3
19	1990-1991	109.4
20	1991-1992	73.1
21	1992-1993	75.4
22	1993-1994	76.6
23	1994-1995	47.6
24	1995-1996	118.8
25	1996-1997	54.1
26	1997-1998	84.9
27	1998-1999	73.3
28	1999-2000	34.3
29	2000-2001	12.1
30	2001-2002	29.9
31	2002-2003	41
32	2003-2004	17.5
33	2004-2005	169.9
34	2005-2006	18.1
35	2006-2007	47.1
36	2007-2008	11.7
37	2008-2009	42.1
38	2009-2010	21.6
39	2010-2011	30.6
40	2011-2012	35.5
41	2012-2013	20.5

Table 4: some of statistical indices for annual rainfall in Zabol synoptic stations (1972-2013)

Station name	Zabol
The mean (μ)	56.0 (mm)
Mean Deviation(σ)	34.76 (mm)
Coefficient of variation(C.V)	62.07 %
Skewness coefficient	0.02663

According to the results in Table 4, it is revealed that the coefficient of variations of rainfalls is 62.07 percent which indicates high irregularities in rainfalls and dominance of dry condition in the area of studied station. [2]

Table 5: Frequency of drought in the Zabol synoptic station period

Wet		<100	41.46
Drought	Threshold	80	14.63
	Poor	70-80	7.32
	Average	55-70	9.76
	Severe	40-55	7.32
	Very severe	40>	19.51

Through the investigation on the percent of normal in the studied region it is revealed that during this period there were 7.32 percent of weak, 9.76 percent of average, 7.32 percent of severe and 19.51 percent of a very severe drought occurred in those years respectively. It should be noted that most of severe droughts as well as very severe ones occurred in recent drought in the region. (The severity of drought is increased compared to previous period).

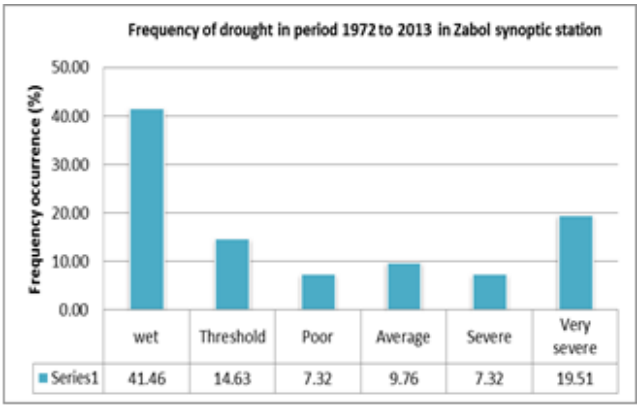

Fig.2. Frequency of drought in previous period in Zabol synoptic station

In analyzing the drought phenomenon in the region the graphs of moving average for 3, 5 and 7 year period drawn after calculating annual rainfall indices.

As it shows in the 5 year-period moving average graph the first dry spell occurred in 1985 and continued until 1990 then a wet spell existed during the period from 1990 to 2000 The second dry spell have happened since 2000 According to the irregular rainfall pattern in the region in the dry spells the high wet spells as well as dry ones are noticeable.

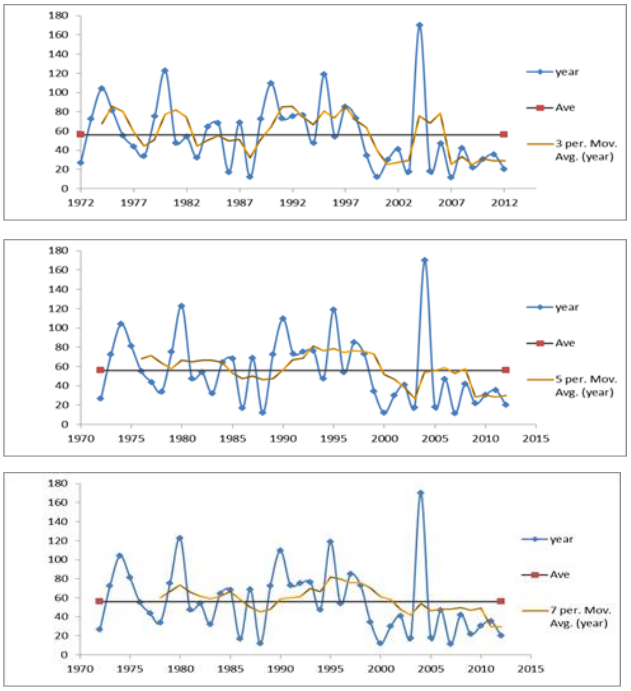

Fig.3. 3, 5 and 7year moving average precipitation in Zabol synoptic station.

The SMADA, MINITAB and EASYFIT programs used for analyzing the rainfall statistics and calculating the severity of droughts with high reoccurrence intervals, The results of analysis is as follows in table 6 & 7 and Figures 4, 5& 6. Kolmogorov-Smirnov (K-S) was used in order to distinguishing the best distribution for embedding the rainfall data as it observed that data was correspondent with Log-Pearson type 3.

Table 6: output data from EasyFit program (Descriptive Statistics)

Statistic	Value
Sample Size	41
Range	158.2
Mean	55.993
Variance	1208.4
Std. Deviation	34.761
Coef. of Variation	0.62082
Std. Error	5.4288
Skewness	1.0924
Excess Kurtosis	1.5904
Min	11.7
Max	169.9

Table 7: Output data from EasyFit program (Goodness of Fit)

Log-Pearson type 3					
Kolmogorov-Smirnov					
Sample Size Statistic P-Value Rank	41 0.09819 0.78814 12				
□	0.2	0.1	0.05	0.02	0.01
Critical Value	0.16349	0.18687	0.2076	0.23213	0.24904
Reject?	No	No	No	No	No

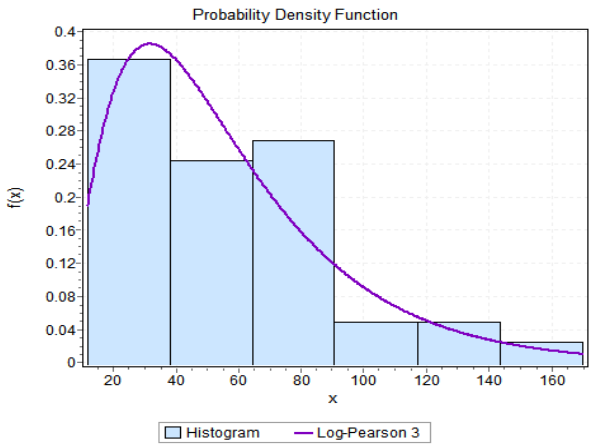

Fig.4. Output data from EasyFit program

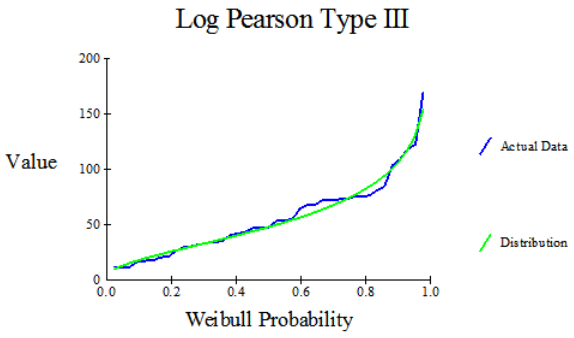

Fig.5. Best embedding graph for output data from SEMADA program

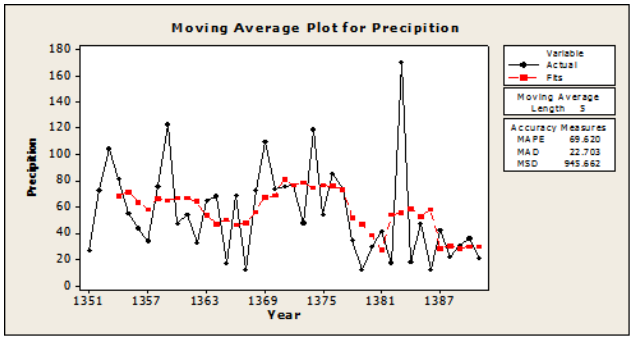

Fig.6. Output data from Minitab program distinguishing the best time series for 5year moving average

Through Mintab-14 program rainfall calculated for dry spells with 5, 10, 25, 50, 100, 200 & 500 recurrence intervals. It shown in table 8,

Table 8: Drought recurrenceintervals through Log-Pearson type 3 distribution

Reoccurrences interval (years)	Rainfall (mm)
5	26.05
10	18.29
25	12.23
50	9.30
100	7.20
200	5.65
500	4.17

III. Discussion and Conclusion

The results of regular drought analysis using moving average and percent of normal in the Zabol synoptic station are as follows:

According to the percent of normal (NP) in the studied region during the studied period

it was observed that there were 7.32 percent of weak, 9.76 percent of average, 7.32 percent of severe and 19.51 percent of very severe drought happened in the region. It should be noted that most of severe and all of very severe droughts belongs to the recent drought dominating the region. (The severity of recent drought increased in compared to the pervious dry spell).

Based on the moving average the first dry spell initiated in 1985 and lasted to 1990 afterwards a wet spell occurred during the period of 1990 to 2000 in the region. The second dry spell started in 2000 and lasted to the end of studied period. Also there is an irregular rainfall pattern exists in the region and high wet as well as dry spells could be observed in the droughts. It was observed that output data was correspondent with Log-Pearson type 3, in the 97 percent level of confidence, for distinguishing the best embedding graph. The calculated rainfall, for the dry spells with 5,10, 25, 50, 100, 200, 500-year reoccurrence intervals are 26.05 (mm), 18.29 (mm), 12.23 (mm), 9.30 (mm), 7.20 (mm), 5.65 (mm) and 4.17 (mm) respectively.

References

[1] Farajzadeh, M.., 2005, Drought… from concept to solution, Geographic organization of the Ministry of Defense and Armed forces publication.

[2] Alizadeh, A., 1995, Principles of applied hydrology, Astan-e-Quds Razavi publication.

[3] Ensafimoghadam, T., 2007, Assessment of climatic drought indices and indicators set Mnaybtryn Salt Lake Basin, Iranian Journal of Range and Desert Research, NO. 2.

[4] Silva, V. P. R. , 2003, On Climate Variability in Northeast Brazil, Journal of Arid Environment, No. 54(2), PP. 256-367

[5] Kaviani, M. R.., 2001, Climatological Survey in drought indices and drought, Geographical Research periodical, numbers 60, p. 79-71.

[6] Tsakiris, G.H., 2004, Towards a Drought Watch system based on Spatial SPI, Water Resources Management, Vol. 18.

[7] Bonaccorso. B., and Others, 2003, Spatial Variability of Drought, An Analysis of the SPI in Sicily, Water Resources Management, No. 17, PP. 273-296.

[8] Guttman, N. B., 1998, Comparing the palmer drought index and the standardized precipitation index. J. the Amer Water Resour. Assoc. 131-121.

[9] Sarhadi, A., S., SoltaniAnd R. Modares, 2008, Assessing the scope of drought in Isfahan based on four important indicators of drought in Isfahan province, Iran Journal of Natural Resources (3), p. 55-57.

[10] Wilhite, D. A., and M. H, Gantz, 1985, Understanding the Drought Phenomenon, The Role of Definitions, Water International, Vol. 10, PP. 111-120.

[11] Wipple, W., 1966, Regional Drought Analysis, ASCE, Journal of Irrigation and Drainage Division, Vol. 92, PP. 11-31.

[12] Hayes, M. J., 2000, What is Drought? Climate impacts specialist. URL, http://www.drought.unl.edu.

[13] Byun, H. R. &Wilhite, D. A., 1999, Objective quantification of drought severity and duration, Journal of Climate, No. 12.

Author's Profile

Mohsen Rezaee
was born in Zahedan, Iran in 1980, He received the M. sc. Degree in Water Engineering from Shahid Chamran University, Ahvaz, Iran, in 2005.
He is Faculty member in Department of Civil engineering, University of zabol, Iran.
Email: M59_rezaee@yahoo.com

Ali Rezvani Mahmuee
was born in Ghaen, Iran in 1983, He received the M. sc. Degree in Environmental Engineeringfrom kharazmi University, Tehran, Iran, in 2008.
Heis Faculty member in Department of Civil Engineering, bozorgmehr University of Ghayenat, Iran.
Email: arezvani@birjand.ac.ir

Samaneh Khaksefidi
was born in Zabol, Iran in 1983, He received the M. sc. Degree in Structural Engineeringin 2010.
She is Faculty member in Department of Civil engineering, University of zabol, Iran.
Email: samaneh112@yahoo.com