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ORIGINAL ARTICLE **OPEN ACCESS**

Assessment of Drought Condition with SPI & PNPI Indexes & using Marcov Chain (Case study: Khorramabad city)

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ABSTRACT
Drought is a situation of wet shortage and temperature increase, possible to happen in any kind of climate. Specifying the drought or wet features in any area is on of the most important elements for recourse management planning in that area. In this study the drought condition in the city of Khorramabad is analyzed based on SPI & PNPI indexes from 1993 to 2013. During the recent statistic period by SPI index, 8 drought cases were seen, the most severe one occurred in 2001whose results were like PNPI index. Then by Markov chain it was tried to design the horizons of drought situation in the current year. Markov chain predicts more than 72 percent of normal wet condition probability using the PNPI index.
Key words*: droughts, SPI, PNPI, Markov chain, khorramabad*

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INTRODUCTION

Drought is a frequent and natural situation occurs in all climates. This phenomenon is a disaster brings about many harmful consequences. The results of an events research done by Japan land national agency represents that between 1992 to 1996 drought was the most occurred natural disaster across the world. Based on accomplished researched in Iran, the direct deficit from any 1mm of decrease in wet trends 98 billion rials. In many parts of country, the people faced lack of wet, dry and semi-dry weather from old times ago aggravating by shortage of wet. Because of being located in the dry geographic region and desert strip in 25 to 45 latitude, Iran has one of the lowest wet averages in the world. In analyzing the drought, there are some special methods; one of them is specifying the indexes which let us evaluate the amount and continuation of drought. This evaluation helps to prevent or decrease the sequels of these phenomena. prediction indexes are mostly based on regional data.

MATERIALS AND METHODS

Study region: Khorramabad city located in Zagros mountainous region. It's in 48 21' longitudes and 33 29' latitude, as well as 1148 meter height from the sea surface and 6233 square km area. The city is located in the center of Lorestan province.

Picture 1: Location of studied region of Khorramabad

Standard of Precipitation Index (SPI):
Standard of precipitation index was defined by McKee and his co-workers in 1993. In fact the concept of SPI index emerged from the reality that the impact of drought on different natural elements is variable. Since the drought in geographic point of view has got a location concept, the severity of drought in any area is a function of coefficient variability of wet in that area. From climatology point of view, level of drought (wet) could be calculated by this equation:

$$SPI = \frac{P_{ik} - P_i}{SD} \quad [1]$$

SPI: Level of drought (precipitation)

P_i : average of annual precipitation

P_{ik}: annual precipitation

SD: scale deviation of annual precipitation

Another feature of SPI index is that the SPI variation expansion includes negative and positive amounts. If drought level is positive, it refers to wet condition and if it's negative, refers to droughts.

Table1- Scale of classification severity of weather forecasting by SPI method.

DROUGHT CONDITION	Abbreviation	Standard distribution classification
Extremely wet	E.W	More than 2
Severely wet	S.W	1.5 to 1.99
wet	W	1 to 1.49
Mild wet	M.W	0.5 to 0.99
normal	NN	0.49 to -0.49
Mild Dry	M.D	-0.5 to -0.99
Dry	D	-1 to -1.49
Severely Dry	S.D	-1.5 to -1.99
Extremely Dry	E.D	less than -2

Precipitation Normal's Percent Index (PNPI):
This index calculates amount of precipitation from long term in area represents in percent. The following equation calculates precipitation normal's percent index:

$$PNPI = \frac{P_i}{\bar{P}} * 100 \quad [2]$$

in which P_j refers to precipitation in the desired year, refers to long term average precipitationand PNPI is precipitation normal's percent index.

Table2: classification of drought amount by means of PNPI method

Severity	Drought				Normal	wet condition
index	Extremely dry	Severe dry	Middle dry	Light dry	Normal threshold	Wet threshold
PNPI	Less than 40	40 to 55	55 to 70	70-80	80 to 120	More than 120

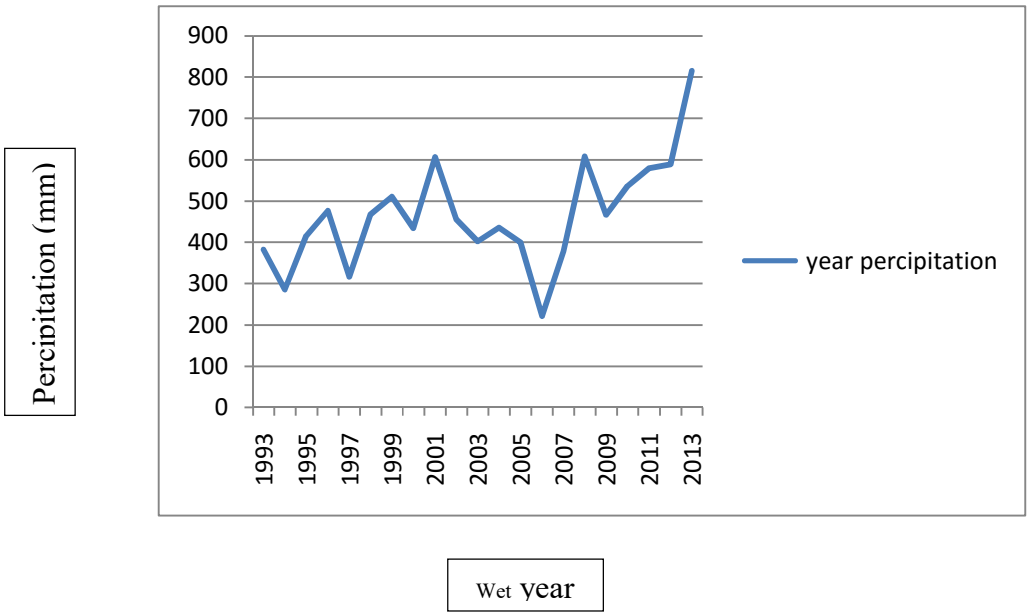
Markov chain:
One of the well knownmethods in analysing the drought is so-called Markov chain. Markov chain is a mathematical methodfor modeling accidental processes that shows possibility of a climate aspect in time, t, in relationship with the time (t-1). This methodis a suitable model to calculating the framework of related possible evidences. (following equation).

$$P_{i,j} = \frac{n_{i,j}}{\sum_{K=1}^{N} n_{i,K}} \quad [3]$$

in which is the possibility of transition from aspect i to aspect j, n is number of transitions from aspect i to aspect j and N refers to number of possible aspects.

RESULTS AND DISCUSSIONS

In this research data of 21 years wet period of Khorramabad weather site were analyzed by SPI and PNPI indexes from 1993 to 2013.

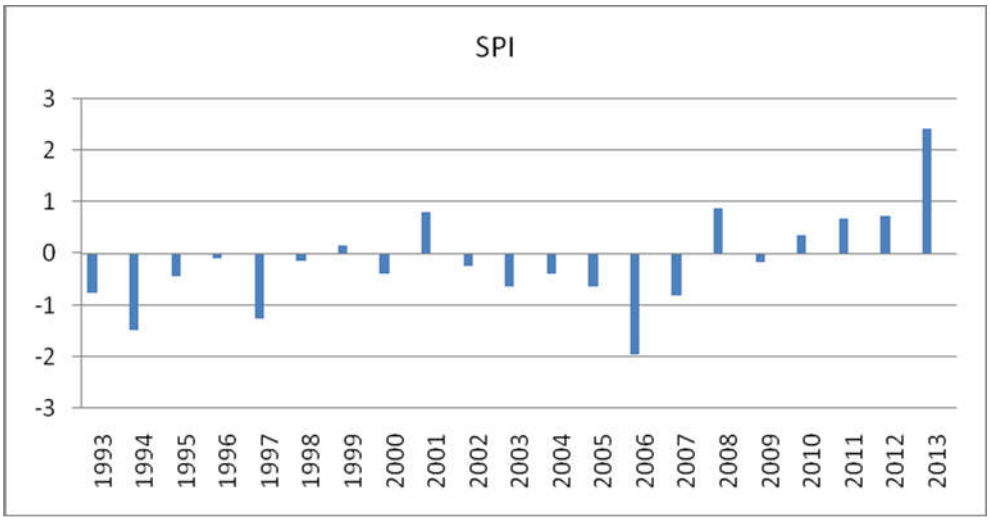


Picture 2: Diagram of annual wet in Khorramabad weather site.

Also picture 3 shows distribution of 21 years period of seasonal wet in Khorramabad.

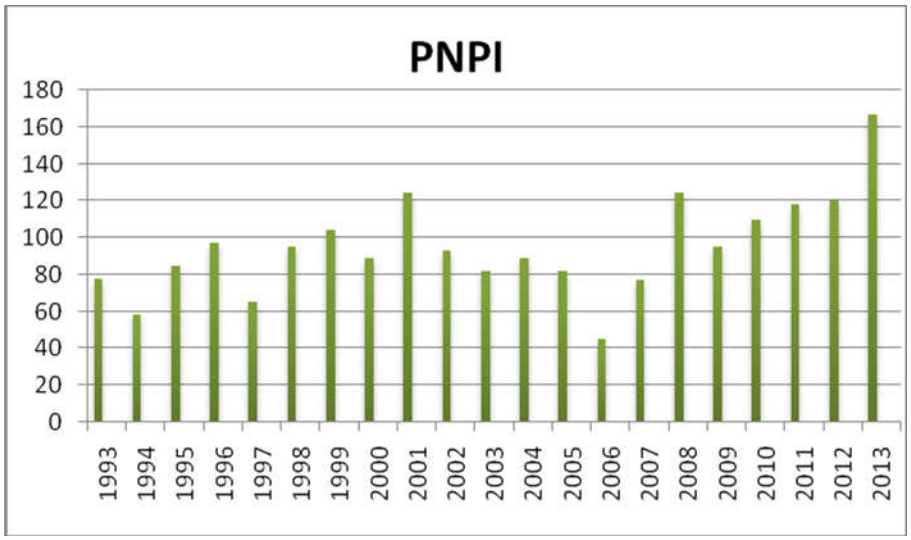
Picture 3: Percentage distribution of 21 years period of seasonal wet Spring: 29%, Summer: 0 %, Autumn: 31%, Winter: 40%

According to results acquired from SPI index, as presented in picture 4 in period of recent 21 years, 8 different cases of drought have been reported, the most severe one was in 2006.



Pic 4: Diagram of SPI annual variations in khorramabad weather forecast site

According to the acquired results from PNPI index, it's found out that also in 2001, 2008,2012 and 2013 threshold of wet occurred; just like drought reported in 1993, 1994, 1997, 2006 and 2007. The other years have had normal condition.



Picture 5: Diagram of PNPI annual variations in khorramabad weather forecast site

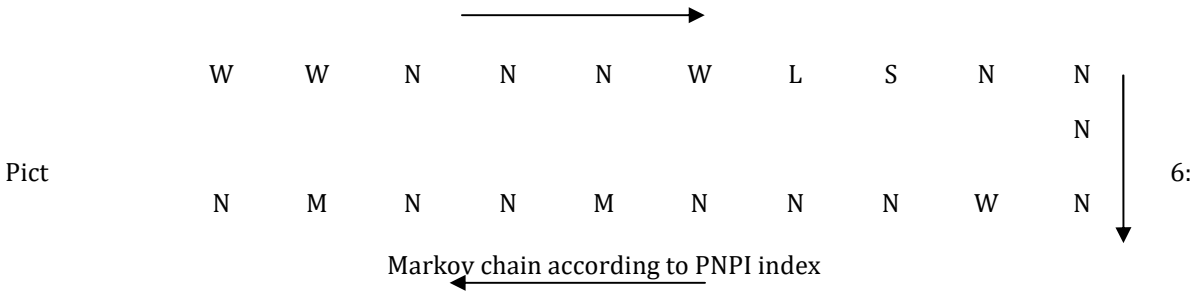
In table3, the comparison of PNPI and SPI indexes are shown.

Table3: comparison of severity of drought by means of PNPI and SPI methods:

Abbreviation	Describing drought PNPI	PNPI	Abbreviation	Describing drought SPI	SPI	Wet year
W	Wet threshold	166.73	E.W	Extremely wet	2.400	1992
W	Wet threshold	120.29	M.W	Mild Wet	0.730	1993
N	Normal threshold	118.45	M.W	Mild Wet	0.664	1994
N	Normal threshold	109.66	NN	Near Normal	0.347	1995
N	Normal threshold	95.34	NN	Near Normal	-0.168	1996
W	Wet threshold	124.39	M.W	Mild Wet	0.877	1997

L	Light dry	77.33	M.D	Mild Dry	-0.815	1998
S	Severe dry	45.21	SD	Severely Dry	-1.971	1999
N	Normal threshold	81.63	M.D	Mild Dry	-0.654	2000
N	Normal threshold	88.99	NN	Near Normal	-0.396	2001
N	Normal threshold	82.04	M.D	Mild Dry	-0.639	2002
N	Normal threshold	92.68	NN	Near Normal	-0.249	2003
W	Wet threshold	123.98	M.W	Mild Wet	0.863	2004
N	Normal threshold	88.79	M.W	Mild Wet	-0.403	2005
N	Normal threshold	104.34	NN	Near Normal	0.156	2006
N	Normal threshold	95.74	NN	Near Normal	-0.153	2007
M	Middle dry	64.65	D	Dry	-1.272	2008
N	Normal threshold	96.77	NN	Near Normal	-0.094	2009
N	Normal threshold	84.29	M.D	Mild Dry	-0.534	2010
M	Middle dry	58.31	SD	Severely Dry	-1.500	2011
N	Normal threshold	80.19	M.D	Mild Dry	-0.786	2012

According to PNPI index calculated in table3 and according to last wet year, by means of Markov chain we can analyse the probability of current wet year. Markov chain (PNPI changing frequency during the statistic period) is shown in picture 6.



Pict 6: Markov chain according to PNPI index

According to Markov chain resulted from PNPI index, 8 times of transition from normal to normal condition and 2 times of transition from normal to wet and 1 times of transition from normal to dry has occurred and totally 11 times of transition from last wet year, means from normal to the other states,has occurred. In equation (4) , probability of transition from last wet year to the other states is represented.

$$P_{N,N} = \frac{8}{11} = 72.73\ \%\ , \qquad P_{N,W} = \frac{2}{11} = 18.18\ \%\ ,$$

$$P_{N,S} = \frac{1}{11} = 9.09\ \%.$$

Equation (4)

CONCLUSION AND SUGGESTION

Study of occurred droughts in Khorramabad weather site were accomplished by means of PNPI and SPI indexes; as shown in table 3and comparison between the indexes, similarity of results in two indexes is palpable. As represented, Markov chain calculates 72 percent of probability of happening a normal wet year. Although Markov chain has predicted a normal wet condition for the current year, that should be considered in last 21 years Khorramabad has experienced a normal tending to drought condition.8 drought period according to SPI index can be a warning for the people and city governors to manage the water recourses in an appropriate way.

Here some solutions for managing the water recourses are suggested: Demand management

- Consideration of watershed management and management for detaining the floods.
- Purifying the house and city sewages for agricultural usages.
- Changing the agricultural irrigation from traditional to modern methods.
- Supplying the required elements to engage thoughtful personnel's and masters of scientific centers related to hydrology researches.

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REFERENCE

1. Hallaaj Mougo'e (2011): assessment of drought consequences on amount of water usage in irrigation and function of agricultural products (case study of Hamidieh irrigation and draining network) master in hydrology science and supplementary studies department, Islamic Azad university of shooshtar.
2. Safaa'e, Derikvand (2011): water utilizing management in drought situation by means of statistic distribution of Markov chain and PNPI index, national water and sewage engineering conference, Kashan city.
3. Amin Alizadeh: principles of practical hydrology, Astanghods publishes, 22th publish 2008.
4. Gholami, Tahtani, (2009).Assessment of environmental effects in Sistan region, second national conference of drought sequels and the ways to manage it, Esfahan ,page 2.
5. McKee , T.B., N.J. Doesken, and Kleist. J., (1993). The relationship of drought frequency and duration to time scales. Proceedings of the 8th Conference on Applied Climatology, Anaheim, CA, USA, pp. Pages 179-184

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