National Drought Early Warning System

Drought is a normal, recurring feature of climate; it occurs in virtually all climatic regimes. It occurs in high as well as low rainfall areas. It is a temporary aberration, in contrast to aridity, which is a permanent feature of the climate and is restricted to low rainfall areas. Drought is the consequence of a natural reduction in the amount of precipitation received over an extended period of time, usually a season or more in length, although other climatic factors (such as high temperatures, high winds, and low relative humidity) are often associated with it in many regions of the world and can significantly aggravate the severity of the event. Drought is also related to the timing (i.e., principal season of occurrence, delays in the start of the rainy season, occurrence of rains in relation to principal crop growth stages) and the effectiveness of the rains (i.e., rainfall intensity, number of rainfall events). Most parts of the I. R. of Iran have a high degree of aridity and pronounced rainfall variability in large parts of their territories and are therefore highly vulnerable to drought. Therefore, drought is one of greatest natural disasters in our country. Among all natural disasters, droughts occur the most frequently, have the longest duration, cover the largest area, and cause the greatest losses in agricultural production. The quantification of impacts and the provision of disaster relief are far more difficult tasks for drought than they are for other natural hazards. Since, the drought is a normal part of climate, it is difficult to determine its onset, development, and end. This fact emphasizes the importance of developing comprehensive monitoring or early warning systems. Satellite- and station-derived data are also proving to be of significant value in drought monitoring. Drought prediction (monthly, seasonal, or yearly trends) is particularly useful for the drought planning and mitigation, which are shown in Figures 1 and 2 for seasonal forecast of precipitation and temperature deviation from normal in I. R. of Iran, by the end of spring 2004. Recently, the CRI and IRIMO (2001) have done research about National Drought Early Warning System in I. R. of Iran (NDEWSI). This system is applied as a pilot study during the last two years. The NDEWSI is based on the monitoring drought indices, such as SPI, Palmer and NDVI, and preparedness, where will be discussed here.

Figure 1: Seasonal prediction of precipitation deviation from mean long term record by the end of winter 2004. *Source: IRIMO, 2004.*

Figure 2 Seasonal prediction of air temperature deviation from mean long term record by the end of spring 2004. *Source IRIMO, 2004.*

The understanding that a deficit of precipitation has different impacts on groundwater, reservoir storage, soil moisture, snow pack, and stream flow led McKee to develop the Standardized Precipitation Index (SPI) in

1993. The SPI was designed to quantify the precipitation deficit for multiple time scales. McKee et al originally calculated the SPI for 3–, 6–, 12–, 24–, and 48–month time scales. The SPI calculation for any location is based on the long-term precipitation record for a desired period. This long-term record is fitted to a probability distribution, which is then transformed into a normal distribution so that the mean SPI for the location and desired period is zero. Positive SPI values indicate greater than median precipitation, and negative values indicate less than median precipitation, as shown in Table 3. Because the SPI is normalized, wetter and drier climates could be represented in the same way, and wet periods can also be monitored using the SPI.

SPI values have been computed for 40 stations of synoptic meteorological stations of IRIMO, representing the different climatic regions across the country for 3-, 6-, 12-, and 24-month scales. The three-month SPI values over Iran are shown in Figure 3. More detailed analysis of SPI for north-east of the country has been done for five time periods (tree-month to twenty-four month) as shown in Figure3- 4. Figure 6 shows time series of the SPI values computed for 12 stations of Khorasan province, with the different climatic conditions, for the 24-month time scale. It is interesting to note that almost all regions suffer from drought to some degree, but not all the regions experience well-defined droughts during the same periods. In other words, temporal distribution and frequency of the dry periods varies markedly among the regions.

The most striking characteristic of the drought is the change in drought frequency as the time scale changes. On longer time scales, drought becomes less frequent but lasts longer. At the 3-month scale, drought frequency increases but its duration decreases. In this report, we have presented a brief drought analysis using the SPI and demonstrated its potential use for drought analysis with minimal data requirements. It is our view that development of a drought monitoring system, based largely on meteorological and climatic information, can be a great help for early assessment of drought impacts in I, R. of Iran. In this sense, the SPI can be a valuable tool for monitoring climatic conditions, particularly in drought-prone areas of the country.

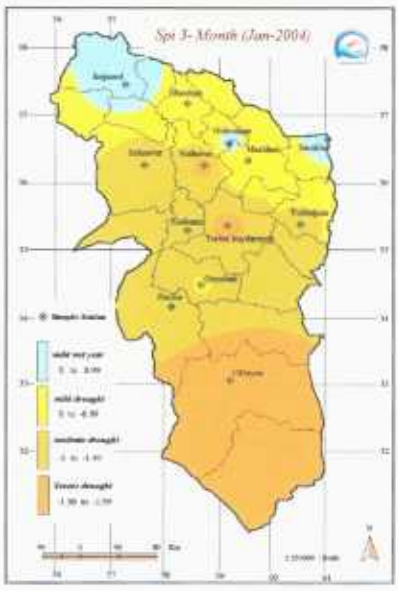


Figure 3: 3-month SPI through the end of Jan *Khorasan Province. Source CRI, 2004*

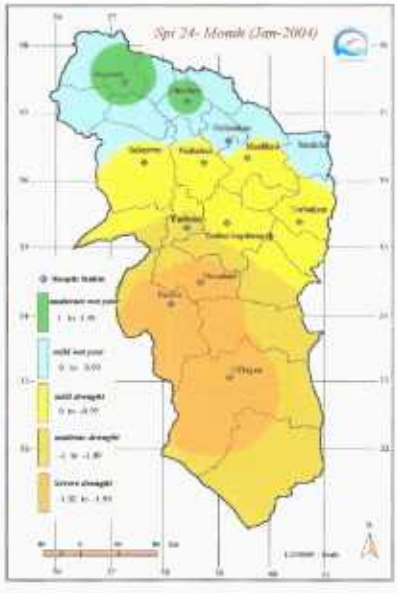


Figure 4. 24-month SPI through the end of Jan *Khorasan Province Source: CRI, 2004*

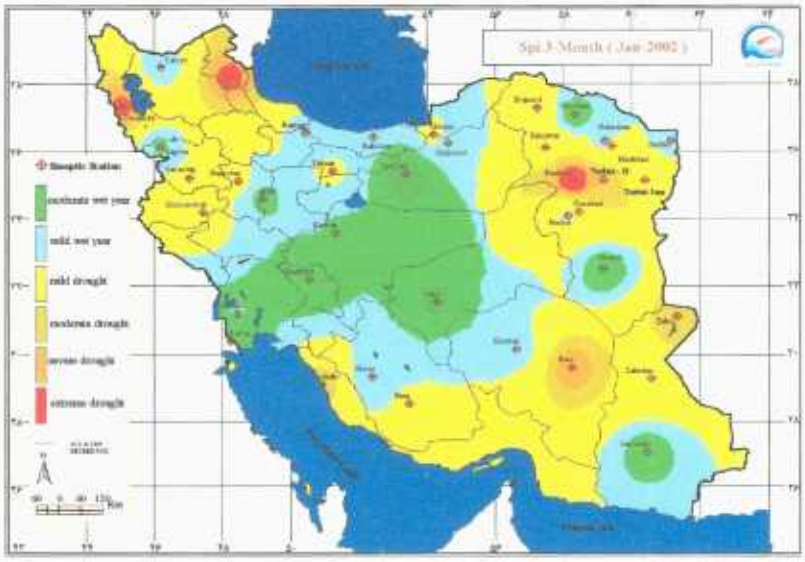


Figure 5: 3-month SPI through the end of Jan 2002 *Source: CRI, 2002*

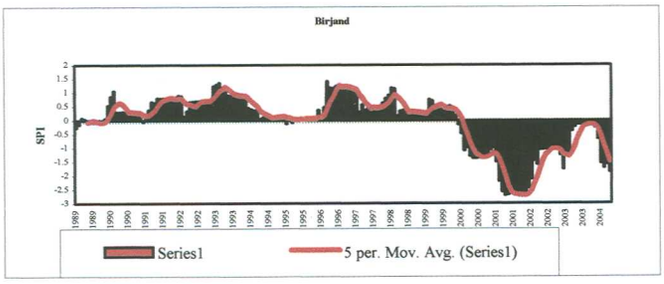
In 1965, W.C. Palmer developed an index to measure the departure of the moisture supply. Palmer based his index on the supply-and-demand concept of the water balance equation, taking into account more than just the precipitation deficit at specific locations. The objective of the Palmer Drought Severity Index (PDSI), Table 2, as this index is now called, was to provide measurements of moisture

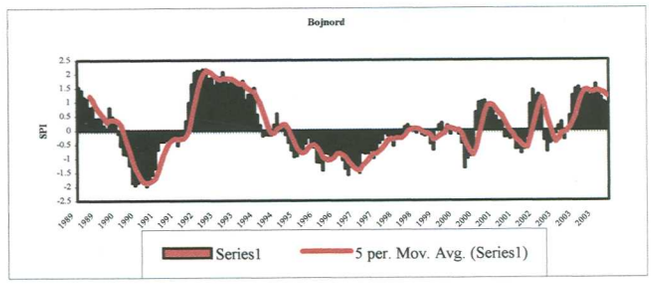
Table 1: SPI Values and Categories

SPI Values	Categories
2.0+	extremely wet
1.5 to 1.99	very wet
1.0 to 1.49	moderately wet
-.99 to .99	near normal
-1.0 to -1.49	moderately dry
-1.5 to -1.99	severely dry
-2 and less	extremely dry

Table 2 PDSI Values and Drought Classifications

Palmer Value	Classifications
4.0 or more	Extremely wet
3.0 to 3.99	Very wet
2.0 to 2.99	Moderately wet
1.0 to 0.99	Slightly wet
0.5 to 0.99	Incipient wet spell
0.49 to 0.49	Near normal
-0.5 to –0.99	Incipient dry spell
-1.9 to –1.99	Mild drought
-2.0 to –2.99	Moderate drought
-3.0 to –3.99	Severe drought
-4.0 or less	Extreme drought


Birjand
SPI
Series1
5 per. Mov. Avg. (Series1)


Bojnord
SPI
Series1
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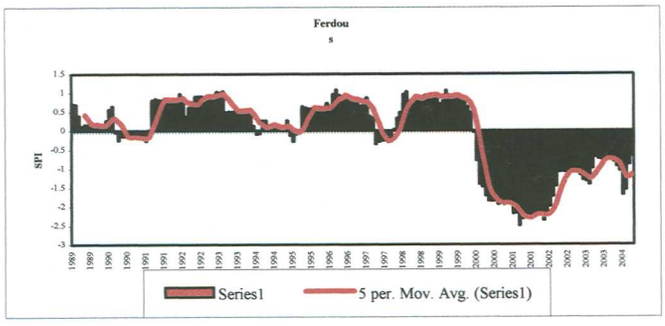
Ferdous
SPI
Series1
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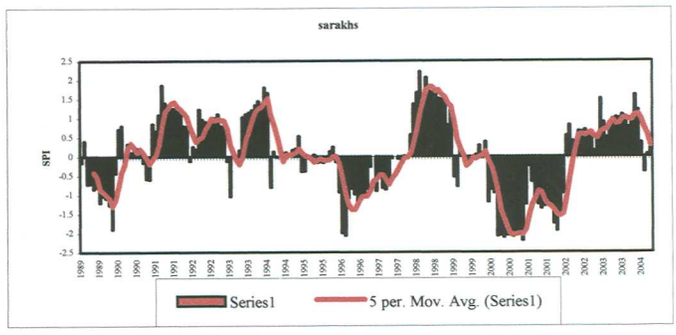
sarakhs
SPI
Series1
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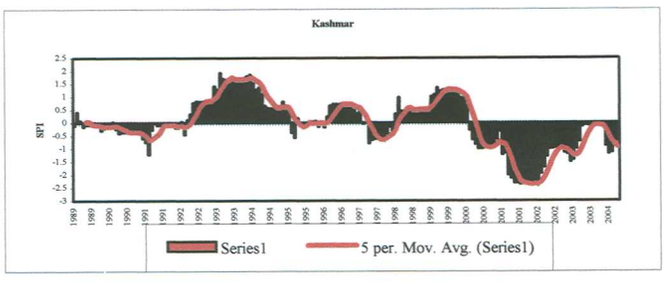
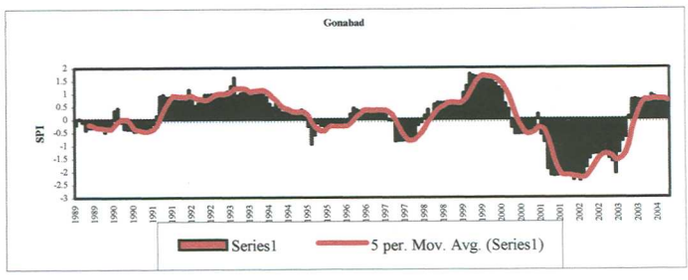

Kashmar
SPI
Series1
5 per. Mov. Avg. (Series1)


Gonabad
SPI
Series1
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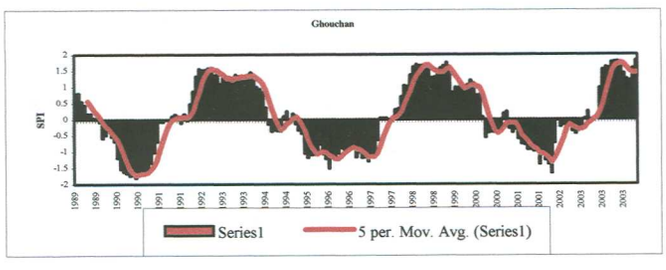
Ghouchan
SPI
Series1
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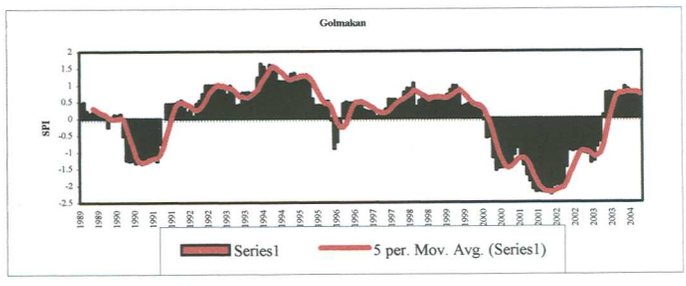
Golmakan
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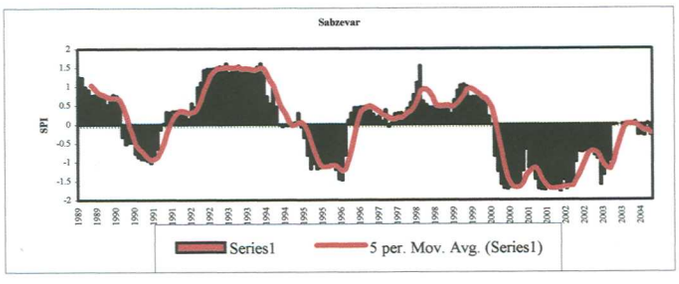
Sabzevar
SPI
Series1
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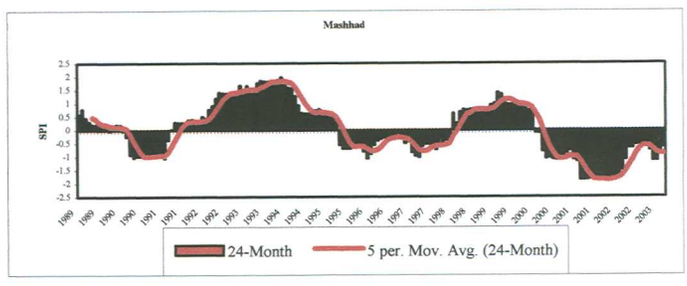
Mashhad
SPI
24-Month
5 per. Mov. Avg. (24-Month)