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Revisiting the SPI: Clarifying the Process

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The number of applications using the Standardized Precipitation Index (SPI) around the world continues to increase (e.g., Agnew, pp. 6–12 of this newsletter, and Komuscu 1999). However, there are relatively few publications explaining the SPI, and occasional misconceptions about the index have occurred.

When the SPI was first developed by McKee et al. (1993, 1995), it was meant to address some of the limitations that exist within the Palmer Drought Index (PDI). These first publications were relatively simple introductions of the SPI to the scientific community, appearing in the *Proceedings* of the Eighth and Ninth Applied Climatology Conferences, respectively, sponsored by the American Meteorological Society. In both cases, the authors define the SPI as the "difference of precipitation from the mean...divided by the standard deviation." It is this equation, given by Komuscu (1999) and repeated by Agnew, that causes confusion about the SPI.

Agnew is correct to point out that the "difference of precipitation from the mean divided by the standard deviation" standardizes the data and has been called the "Standardized Rainfall Anomaly" by Jones and Hulme (1996). Variations of standardized rainfall anomalies have been used with data sets, especially analyzing African rainfall. It is important to point out, however, that this is not the SPI! There is a difference between standardizing precipitation data using the equation above and the SPI, and it is easy to miss this difference. In the cases of McKee et al. (1993, 1995) and Komuscu (1999), the authors briefly mention that the long-term data sets used to determine the SPI at any time scale must first be normalized. Readers of these articles may overlook this step. The normalization procedure using a probability distribution is a very important feature of the SPI and makes it unique. Edwards and McKee (1997) first highlight this important distinction and give a detailed description of how this is done for the SPI. People will frequently ask, "What is the equation of the SPI?" Edwards and McKee (1997) illustrate that it is more of a "process" to determine an SPI value.

In 1998, Guttman wrote an article comparing the SPI with the PDI that contained a more detailed explanation about determining the SPI. Hayes et al. (1999) also contains a detailed description of the process. Guttman (1999) went into the specifics about different probability distributions applied to the long-term data sets and examined the impact of six distributions on the SPI. The recommendation from Guttman (1999) is that the Pearson Type III distribution is "best" suited to normalize the long-term data sets when calculating the SPI. Edwards and McKee (1997) used the two-parameter gamma distribution to calculate the SPI. Guttman (1999) also recommended that the procedure be uniform for everyone so that applications of the SPI would be consistent. Different software versions to determine the SPI are now available from Colorado State University and the National Climatic Data Center.

Agnew makes another very good point about identifying appropriate drought categories, and points out that the initial categories identified in the original McKee et al. (1993, 1995) articles had a location for any time period in some stage of "drought" 50% of the time. Table 1 below shows the NDMC modifications to the categories identified by Agnew in his table on p. 6 of this issue. The term *dry* is used because that is more appropriate for short time scales, and the categories reflect the lower percentages that should occur with dry periods, especially with the labels *severe* and *extreme*. These categories are also the basis for the monthly national SPI maps that are displayed on the National Drought Mitigation Center's website (http://enso.unl.edu/watch/). Guttman (1999) uses the same categories. The Western Regional Climate Center

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 1. SPI values.

uses a slightly different set of categories in monthly national SPI maps displayed on their website (http://www.wrcc.sage.dri.edu/spi/spi.html). Finally, Agnew suggested the classification of categories based on the 5%, 10%, and 20% occurrence probabilities, which is also a very good system (see Agnew's second table on p. 10 of this issue).

In his article, Agnew brings up another important point that needs to be emphasized. Precipitation normals do shift at all locations depending on the period being considered "normal." Such shifts would certainly have an impact when standardizing precipitation data, but they also can affect the SPI. This is why it is hoped that the data sets of 100 years, or as long as possible, could be used in determining the SPI. Guttman (1999) recommends at least 50 years of data to compute SPI values for time periods smaller than 12 months, and a longer record to compute multiyear SPI values is desired.

Finally, Agnew reminds everyone that indices based on precipitation alone do not take into account specific drought impacts. These impacts will vary based on the vulnerability of the society and environment of each particular region. The SPI and other indices are only tools to help decision makers understand events that are taking place. It is good to have one or more of these tools, but the decision makers have to become familiar with how to apply these tools and understand their strengths and limitations in local situations.

The articles by Komuscu (1999) and Agnew demonstrate that the number of drought monitoring applications using precipitation indices is increasing. We welcome the discussion of indices and their applications in future issues of *Drought Network News*. It is very important that this information relating to "lessons learned" from a drought monitoring perspective is shared with the drought planning community.

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References

Edwards, D. C.; and T. B. McKee. 1997. "Characteristics of 20th century drought in the United States at multiple time scales." Climatology Rep. 97–2, Department of Atmospheric Science, Colorado State University, Fort Collins, Colorado.

Guttman, N. B. 1998. "Comparing the Palmer Drought Index and the Standardized Precipitation Index." *Journal of the American Water Resources Association* 34(1):113–21.

Guttman, N. B. 1999. "Accepting the Standardized Precipitation Index: A calculation algorithm." *Journal of the American Water Resources Association* 35(2):311–22.

Hayes, M. J.; M. D. Svoboda; D. A. Wilhite; and O. V. Vanyarkho. 1999. "Monitoring the 1996 drought using the Standardized Precipitation Index." *Bulletin of the American Meteorological Society* 80(3):429–438.

Jones, P. D.; and M. Hulme. 1996. "Calculating regional climatic time series for temperature and precipitation: Methods and illustrations." *International Journal of Climatology* 16:361–377.

Komuscu, A. U. 1999. "Using the SPI to analyze spatial and temporal patterns of drought in Turkey." *Drought Network News* 11(1):7–13.

McKee, T. B.; N. J. Doesken; and J. Kleist. 1993. "The relation of drought frequency and duration to time scales." *Proceedings of the Eighth Conference on Applied Climatology*; pp. 179–84. American Meteorological Society, Boston.

McKee, T. B.; N. J. Doesken; and J. Kleist. 1995. "Drought monitoring with multiple time scales." *Proceedings of the Ninth Conference on Applied Climatology*; pp. 233–236. American Meteorological Society, Boston.