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A Drought Watch System for Southeast Spain

Ramon Garrido Abenza
National Institute of Meteorology, Territorial Meteorological Center of Murcia, P. O. Box 138, Espinardo. 30071 Murcia, Spain

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Introduction

One of the main climatological characteristics of the region of Murcia (11,300 km^2), located almost entirely in the Segura Basin (in southeast Spain), is the great temporal and spatial irregularity of its precipitation. Average annual precipitation values range between 200 and 500 mm, and coefficients of variation (CV) are high, with some values about 50%. It is a semiarid region (including a small arid area), and agriculture plays a major role in its economy. Because of this, drought is one characteristic of the region's climate that has far-reaching consequences, from unemployment to social conflicts.

It is important to define drought and identify appropriate indicators for the region of Murcia as part of a drought watch system. This system will define the temporal and spatial limits of drought conditions. It would help policy makers and government officials establish policies for the provision of aid to farmers and cattlemen, as in Australia (White and O'Meagher, 1995).

Because of the wide range of drought impacts, there are many definitions of this phenomenon. However, one characteristic seems common to all of them: drought is caused by a deficiency in precipitation for a fairly long period of time. For simplicity, and keeping in mind that precipitation is, without doubt, the most important variable in the process, the watch system developed for the region of Murcia uses only this variable at the moment, establishing a comparison with a climatological reference (1961–90) that we consider "normal."

Regarding Some Precedents

Up to now, the National Institute of Meteorology in Spain has used a method of quintiles of the cumulative distribution function (c.d.f.) of precipitation, with normal precipitation corresponding to the second and third quintiles (c.d.f. between 40% and 60%). Using this method, the region is usually (80% of the time) facing a situation that is not normal. The watch system for Australia by Gibbs (1987) extends the "normal" category from the third through seventh deciles (c.d.f. between 30% and 70%), but the criteria that are used to establish the beginning and end of a drought do not apply in the southeast Iberian Peninsula.

On the other hand, using the Palmer Drought Severity Index (PDSI) would require more data and assume hypotheses that are not always suitable. Another added inconvenience would be that certain situations, such as extreme or severe drought, would occur more frequently in some areas than in others (Willeke et al., 1994). Furthermore, the category of extreme drought occurs too frequently for some regions, in excess of 10% for some areas (Wilhite, 1993).

The use of the Standardized Precipitation Index (SPI) (McKee et al., 1993) would introduce the great advantage of standardization, allowing us to determine the rarity of an episode in terms of probability. However, the fixed limits among the categories do not arise in an intuitive way (there is a mixture of whole and fractional numbers) and the normal category seems too extensive (68% of all occasions), so that some descriptive power would be lost.

The Drought Watch System in the Region of Murcia

To incorporate the descriptive power of the PDSI and the advantages of the standardization of the SPI, we have created the Normalized Precipitation Index (NPI), which is calculated with the following equation (Garrido, 1998):

$$F(x) = \frac{1 + Erf\,(NPI / \sqrt{8})}{2}$$

where *F(x)* is the empirical c.d.f. and *Erf* ( ) is the error function (this equation must be solved by means of numerical methods). Imposing threshold values of ±4 for the NPI for the extreme categories, as happens in the case of the PDSI, we obtain the classification in Table 1. The values of the index and the names of the categories generally coincide with those of the Palmer classification. The most probable category is the normal one, even using a wider classification that groups drought or wet cases, while the percentages or probabilities of the moderate, severe, and extreme categories coincide with those of the SPI. In the extreme categories, only 2.3% of the situations are included, which is a typical percentage of an extreme event (Wilhite, 1995).

Of course, this methodology can be applied to other variables, such as the precipitation volume in a region, hydrographic basin, or catchment area, leading, in this case, to a Normalized Volume of Precipitation Index (NVPI). It can be applied on various temporal scales, like a month, season, or year.

In the region of Murcia, given the great variability and seasonal distribution of the rain, it is essential to use an index that removes seasonal data, like the precipitation collected in the last 12 months. Such an index has the advantage of stability, and it allows a prediction (not a prediction in the usual sense of the word, but rather a trend) of its future values, since, at any moment, these values can be inferred from climatological references. A simulation showed that the prediction of the 12-month NVPI can extend for a term of 5 months, with an average absolute error inferior to the unit.

The watch system, which was instituted in January 1998, consists of two parts. The first part (Figure 1) is limited to the consideration of the NVPI on scales of 1 and 12 months, offering information about what happened in the last 4 years, with special emphasis on the previous 2 years. It also offers a prediction of the values of the index, up to 5 months ahead, and it establishes the excess or deficit quantities of precipitation in relation to the threshold values of the 12-month NVPI.

In the second part, to study the geographical distribution, the NPI values are also represented (Figure 2) on temporal scales of 1 and 12 months. The average value of those indexes in the region should always be similar to the corresponding NVPI values.

NPI	Category	c.d.f. (%)	Time in category (%)	
4 or more	4: Extremely wet	97.7 (100)	2.3	
3 to 4	3: Very wet	93.3 (97.7)	4.4	
2 to 3	2: Moderately wet	84.1 (93.3)	9.2	30.9
1 to 2	1: Slightly wet	69.1 (84.1)	15.0	
-1 to 1	0: Normal or near normal	30.9 (69.1)	38.3	38.3
-2 to -1	-1: Mild drought	15.9 (30.9)	15.0	
-3 to -2	-2: Moderate drought	6.7 (15.9)	9.2	
-4 to -3	-3: Severe drought	2.3 (6.7)	4.4	30.9
-4 or less	-4: Extreme drought	0 (2.3)	2.3	

Table 1. NPI classifications for dry and wet periods.

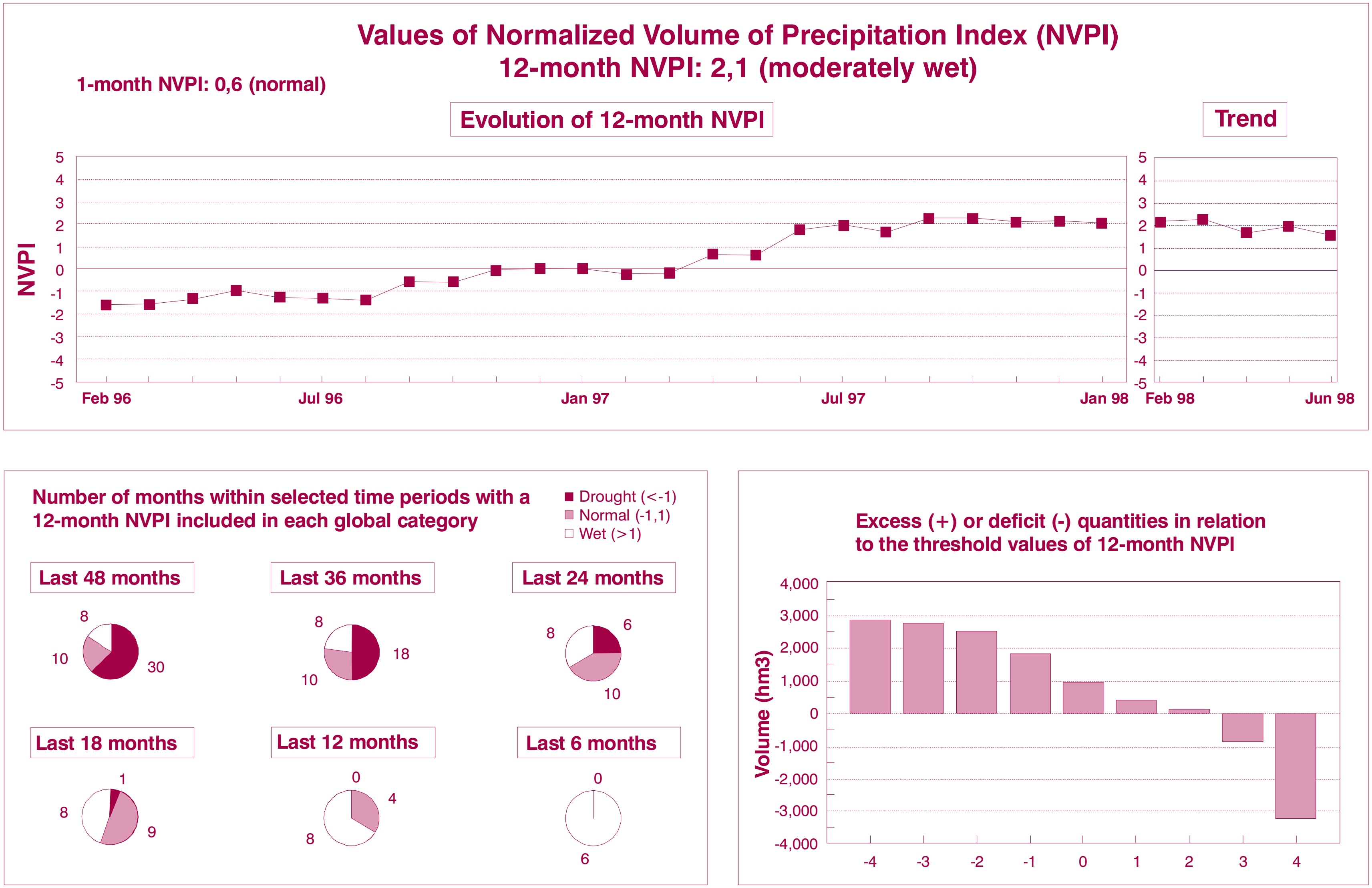

Figure 1. Drought watch system in the region of Murcia, January 1998.

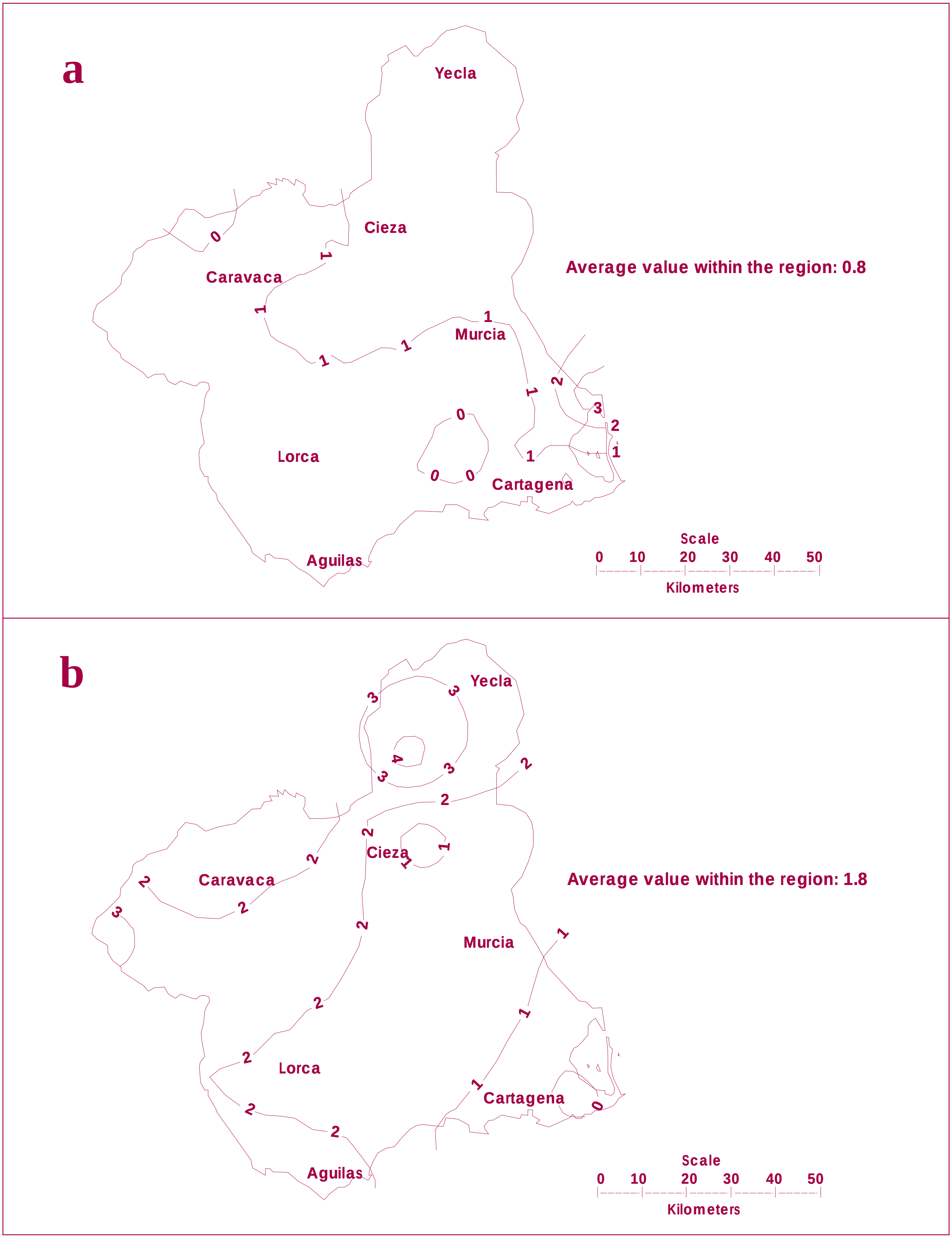

Figure 2. Normalized Precipitation Index values, January 1998: (a) 1-month; (b) 2-month.

Future Development

The system will be extended to the whole Segura Basin, and it will be developed to expedite the capture of precipitation data (appealing to automatic observation networks, for example); to increase the number of temporal scales, mainly those of 3 and 6 months time; and to extend the term of the forecasts, incorporating information based on the climatic teleconnections. Designing a watch system based on some type of normalized water balance would also be a future objective.

Ramón Garrido Abenza
National Institute of Meteorology
Territorial Meteorological Center of Murcia
P. O. Box 138, Espinardo. 30071 Murcia
Spain

References

Garrido, R. 1998. "Un sistema de seguimiento de la sequía en la Region de Murcia." In *I Asamblea Hispano-Portuguesa de Geodesia y Geogisica.* Almería, Spain, in press.

Gibbs, W. J. 1987. *A Drought Watch System.* World Meteorological Organization, TD no. 193, WCP–134.

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

White, D. H.; and B. O'Meagher. 1995. "Coping with exceptional droughts in Australia." *Drought Network News* 7 (2):13–17.

Wilhite, D. A. (ed.) 1993. *Drought Assessment, Management and Planning: Theory and Case Studies.* Kluwer Academic Publishing, Dordrecht, The Netherlands.

Wilhite, D. A. 1995. *Developing a precipitation-based index to assess climatic conditions across Nebraska.* Final report to the Natural Resources Commission, Lincoln, Nebraska.

Willeke, G.; J. R. M. Hosking; J. R. Wallis; and N. B. Guttman. 1994. *The National Drought Atlas*. Institute for Water Resources Report 94-NDS-4, U.S. Army Corps of Engineers.