8.2 MONITORING DROUGHTS WITH IMPROVED DROUGHT INDEX RESOLUTION

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1. INTRODUCTION

Given their complexity, droughts have always been difficult to monitor. For this reason, scientists have developed drought indices in attempts to best monitor the intensity, duration, and spatial extent of droughts. The other goal of a drought index is to put a current drought event into a historical context. Two drought indices, The Palmer Drought Severity Index (PDSI) (Palmer 1965) and the Standardized Precipitation Index (SPI) (McKee et al. 1993, 1995) have been widely used in monitoring drought in the United States and across the world.

Both the PDSI and SPI have characteristic strengths and weaknesses that make the indices unique. However, one of the common weaknesses is that these indices when displayed for the U.S. are mapped at a spatial resolution represented by climate divisions. The SPI has been further limited to monthly calculations, a temporal resolution too coarse to aid decision-makers attempting near-real time responses to droughts.

As part of a Digital Government grant from the National Science Foundation, scientists in the Computer Science and Engineering (CSE) Department at the University of Nebraska, along with assistance from the National Drought Mitigation Center (NDMC) and the High Plains Regional Climate Center (HPRCC), have developed the codes to calculate and plot both the SPI and PDSI on a weekly basis for stations in the Great Plains. These advancements should dramatically improve drought monitoring capabilities by providing drought severity information at better spatial and temporal resolutions. This paper describes this process, and outlines some of the potential uses of this information for decision makers.

2. PDSI IMPROVEMENTS

Although fraught with weaknesses that limit its application as a drought index, the PDSI is still widely used across the United States. One of its biggest weaknesses is that when weekly and monthly PDSI values are mapped for the U.S., these values are computed at a coarse climate division scale. Such aggregation can misrepresent the severity of drought conditions in a region, especially where multplie physiographic regions dissect a climate division.

In order to address this weakness, the PDSI code was rewritten to calculate PDSI values at a station level and then use spatial surfacing techniques to provide an interpolated version of the index. The PDSI calculation is extremely complex, and the inputs needed for this calculation include precipitation, temperature, and the available water-holding capacity (AWC) of the soil. Typically the climate variables are averaged to provide one value for the climate division. Likewise, one AWC value also represents the entire climate division, which fails to reflect the diversity of soils. One of the important features of the new PDSI code is that it draws upon the root zone available water-holding capacity (Soil Survey Staff, 2000) characteristic of each station, providing a unique AWC value and greatly improving the accuracy of this component of the calculation.

3. SPI IMPROVEMENTS

The SPI was developed at Colorado State University (McKee et al. 1993) to complement the PDSI and address many of the PDSI's weaknesses. The most important SPI strength is that it can be calculated for any temporal window. Therefore, if one is interested in short-term applications for the index, an SPI can be calculated for 1-, 2-, or 3-month time periods. If one is interested in long-term applications, such as in water resources planning, a 12- or 24-month SPI can be examined.

The SPI, however, also has several limitations. One limitation, like the PDSI, is that the precipitation totals to calculate the SPI for national maps are averaged to one climate division value. The second limitation is much more significant. The original SPI code was developed to calculate the SPI for monthly periods. Any time period from one to 72 months could be selected, but the values could only be updated every month. These monthly updates for the national maps are made available from web sites at the Western Regional Climate Center [http://www.wrcc.sage.dri.edu/spi/spi.html] and the NDMC [http://enso.unl.edu/ndmc/watch/spicurnt.htm] 6-14 days after the end of a particular month. This severely limits the operational use of the SPI information for near-real time decision making during drought situations.

In order to address these SPI limitations, code was written so that the SPI can be calculated by station and updated in near-real time on a weekly basis. Therefore, it is now possible to produce an SPI map for a 6-week period half-way through a month. This improvement significantly increases the timeliness of the SPI and makes it a much more powerful tool for drought monitoring, vulnerability mapping, and decision support.

4. DATA AVAILABILITY

To meet the data needs required to make the necessary improvements to the SPI and PDSI, the CSE Department at the University of Nebraska works closely with the HPRCC. Daily data for the COOP stations in Nebraska are gathered and aggregated into weekly periods. Historical data are organized in the same

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fashion to provide the historical context needed for both indices.

Eventually, data collection will be expanded to cover the rest of the High Plains, and could be expanded to include the rest of the nation through incorporation of the Unified Climate Access Network (UCAN) currently in development by the Regional Climate Centers.

5. WEB INTERFACE

The SPI and PDSI codes and user guides have been made available on a web interface constructed to feature the Digital Government project, called the National Agricultural Decision Support System (NADSS) [http://nadss.unl.edu/]. With access to this interface, users will be able to select the index, time period, stations, and surfacing algorithm in order to generate a statewide surface, with optional county-level or watershed overlays. This information will be timely, providing important information to decision makers available in a map or table format.

The web interface also includes the Newhall Simulation Model, a soil water balance developed by the Natural Resources Conservation Service (NRCS), for deriving soil climate applications that incorporates precipitation, temperature, and soil water-holding capacity (Van Wambeke et al. 1992, Waltman et al. 1997) to create probability surfaces of soil moisture regimes and their shifts in time and space.

Figure 1 shows the entry page of the web interface for selecting the suite of weather stations and temporal windows that generates an SPI map for Nebraska. The user can select the starting and/or ending dates, time scale desired, interpolation method, and output style. As the project continues, the user will be able to select various states and/or regions as well.

6. CONCLUSIONS

The objective of the NADSS project was to provide decision support tools for the USDA Risk Management Agency (RMA). RMA is the principal agency responsible for crop insurance issues in the U.S. and is very interested in tools, such as the SPI and PDSI, to help in drought-related exposure analyses (the verification of crop losses attributable to drought).

Certainly, improving the temporal and spatial resolution of the SPI and PDSI indices will help RMA and others in making timely decisions during droughts. One of the reasons why the SPI is not currently being used more directly in the weekly Drought Monitor [http://enso.unl.edu/monitor/index.html] process is because the monthly constraint on the calculations. The web interface makes this information readily available and it is hoped that other scientists and researchers will begin to use the new codes to work with these drought indices.

7. ACKNOWLEDGMENTS

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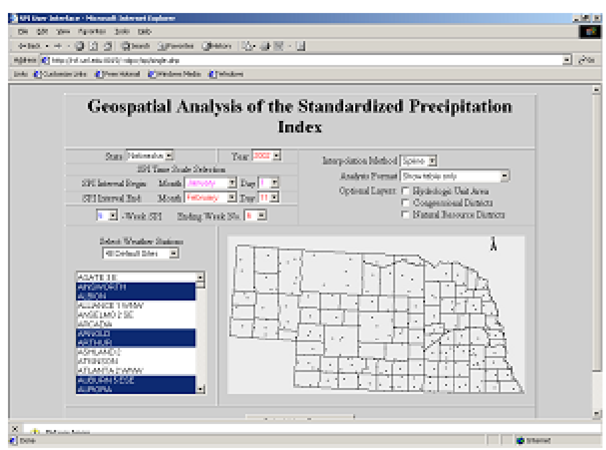

Figure 1. Entry page of the web interface designed for the NADSS project for generating an SPI map for Nebraska.