Documentation for the Original and Self-Calibrating Palmer Drought Severity Index used in the National Agriculture Decision Support System

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Abstract

The National Agriculture Decision Support System (NADSS) is a collection of decision support tools. Drought indices can be very important tools for agricultural planning. NADSS offers users information from the Palmer Drought Severity Index (PDSI). The original PDSI was designed in 1965, and has several well-known shortcomings. An improved implementation of the PDSI is the Self-Calibrated PDSI, which is also offered as part of NADSS.

There are several subtle characteristics of the calculation and behavior of the PDSI that are many time overlooked by users of the PDSI. This documentation was created to (1) inform users of NADSS of these subtleties and (2) introduce the concepts used in the Self-Calibrated PDSI, allowing them to more accurately interpret the information supply through NADSS.

Note on this document:
The information provided in this document was designed first and foremost for publication on the web, and it can be viewed at http://nadss.unl.edu/ . This document is simply a collection of the information into a single document for easier distribution. Readers should refer to the web page for the most up-to-date information, as well as for higher quality images.

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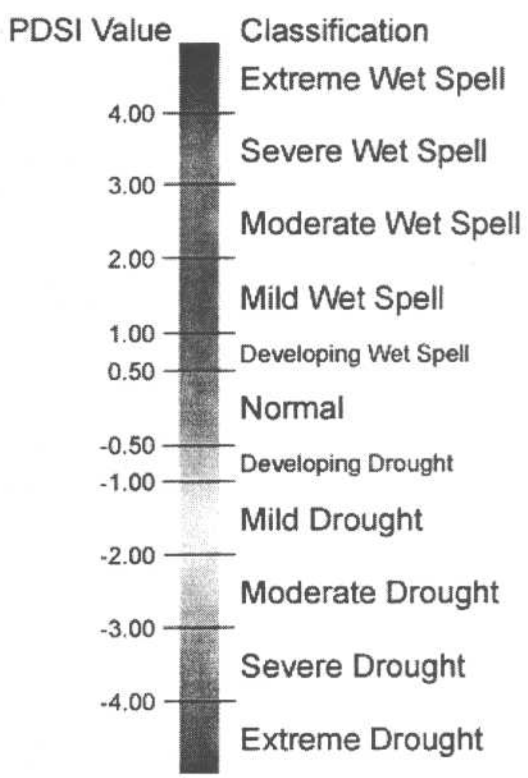
What is the Palmer Drought Severity Index?

The Palmer Drought Severity Index is usually abbreviated to PDSI, but sometimes the "Severity" part is left out and it is called the PDI. Throughout the course of this documentation, it will be referred to as PDSI.

The PDSI was developed during the early 1960's by W. C. Palmer as a standard way to quantify the severity of drought conditions. Palmer published his method in the 1965 paper, "Meteorological Drought" for the Office of Climatology of the U.S. Weather Bureau. Since then, the PDSI has become one of the most widely used drought assessment tools. The federal government and many state governments rely on the PDSI to trigger drought relief programs.

Unlike the Standardized Precipitation Index (SPI), which is another popular drought index, the PDSI is based on more than just precipitation. The PDSI actually uses a supply and demand model for the amount of moisture in the soil. The value of the PDSI is reflective of the how the soil moisture compares with normal conditions. A given PDSI value is usually a combination of the current conditions and the previous PDSI value, so the PDSI also reflects the progression of trends, whether it is a drought or a wet spell. That means that a single PDSI value is not representative of just the current conditions, but also of recent conditions to a certain extent.



Palmer defined the scale at the left for the PDSI. The categories run from "mild" to "moderate" to "severe" to "extreme". The normal range of PDSI values is from -0.50 to +0.50. Any PDSI values above +4.00 or below -4.00 fall into the "extreme" category of wet spell or drought. This scale was arrived at somewhat arbitrarily, which has been one of the criticisms of the PDSI.

The motive behind the development of the PDSI was to create a standard tool for quantifying severity of the effects of droughts. Exactly what is meant by "the effects of droughts" is a little vague, since droughts have wide ranging consequences. However, Palmer decided that the severity of a drought's effects is proportional to the relative change in climate. For example, if a climate that usually has very slight deviations from the normal experiences a moderate dry period, the effects would be quite dramatic. On the other hand, a very dry period would be needed in a climate that is used to large variations to produce equally dramatic effects. So the effects of a drought can be approximated by simply quantifying the unusualness of the climate conditions.

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Palmer wanted a single methodology that could be used in any climate that was accurately representative of how the drought conditions affect that local climate. In other words, a PDSI of -4.0 in Western Texas should be similar to a PDSI of -4.0 in coastal Washington, even though coastal Washington will, even in its driest years, receive several times more rain than Western Texas. The procedure he developed involves calculating the moisture deficit or surplus and then weighting that value according to several factors of the historical behavior of the local climate. Successfully weighting the value should mean that it is representative of the severity of the conditions for the local climate.

How the PDSI is calculated

The PDSI is based around a supply and demand model of the soil moisture at a location. The supply is the amount of moisture in the soil plus the amount that is absorbed into the soil from rainfall. The demand, however, is not so as easy to see, because the amount of water lost from the soil is depends on several factors, such as temperature and the amount of moisture in the soil.

Potential Evapotranspiration

Abbreviations

PET	Potential Evapotranspiration
PR	Potential Recharge
PRO	Potential Runoff
PL	Potential Loss
ET	Evapotranspiration
R	Recharge
RO	Runoff
L	Loss
AWC	Available Water Holding Capacity
Ss	Surface Soil Moisture Content
Su	Underlying Soil Moisture Content

The basis of the soil modeling is the calculation of the **potential evapotranspiration** (PET). **Evapotranspiration** (ET) is, as one would guess, the combination of evaporation and transpiration, and in this context, refers to the amount of water lost from the environment through vegetation and evaporation. PET is calculated using **Thornthwaite's** method. Thornthwaite's method of calculating PET is much too complicated to explain on a web page, but here is some code, written in C, to look at if the desire is there to know exactly how it is done. It is suffice to say that the monthly PET depends on that month's average temperature, average temperature of that month over all historical record, and the latitude of the weather station.

One important thing to note is that Thornthwaite's method is an approximation of PET. It has been around for quite a long time, and is generally considered the accepted method to calculated PET, but it has seen some disagreement over how accurate it is. There has also been some criticism that the PDSI relies too heavily on Thornthwaite's. It is true that the PDSI relies heavily on the calculation of PET, but the PDSI could easily use another method to approximate PET.

Besides PET, there is also **potential recharge** (PR), **potential runoff** (PRO), and **potential loss** (PL). Before getting into how these are calculated, another definition is needed. The **Available Water Holding Capacity** (AWC) is the amount of water the soil is capable of holding. The