Development and Testing of Drought Indicators

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Abstract. Numerous definitions of droughts which are based on different climatological time series have been in use. In this paper, the development of drought indicators by using different time series is described. These drought indicators were developed for use by the Department of Natural Resources in the State of Indiana, U.S.A. The second part of the study deals with an analysis of the consistency of results obtained by using different time series, in order to select two or three of the commonly available series for drought analysis. Past drought data are used to test the performance of the drought indicators. As a result of this study, three month precipitation, monthly river flow and the Palmer Hydrologic Drought Index series are recommended for operational use.

Key words: drought, drought warning, Palmer's Hydrologic Index, stream flows, precipitation

1. Introduction

Drought severity is dependent both on water shortage and on water use. If there is no need for water, the question of shortage does not arise at all. To illustrate this relationship, consider the effects of a three month rainfall deficit. Although stream flows may be seriously affected by shortage or lack of rainfall, the duration or magnitude of the precipitation deficit may not be sufficient to affect ground water levels. Consequently, different severity levels must be established for ground water and stream flows.

Because the indication of a drought by one variable does not necessarily indicate drought if another variable is used, the following variables are investigated in this study: precipitation, summer temperatures, river flows, and Palmer Hydrologic Drought Index (PHDI). Data from the State of Indiana are used in the present study.

The National Oceanic and Atmospheric Administration has divided Indiana into nine climatological regions, and PHDI values have been computed for these nine regions for the period of record used in this study (1895–1988). Because the state of Indiana is not climatologically homogeneous, it is divided into three drought regions as shown in Figure 1. Drought region 1 contains PHDI regions 1, 2, and 3, region 2 contains PHDI regions 4, 5, and 6, and region 3 contains PHDI regions 7, 8, and 9. The Indiana drought regions were defined with cooperation from the Indiana Department of Natural Resources.

Drought severity indicators are needed by the Indiana Department of Natural Resources to manage the surface water resources and to issue warnings of impend-
The first objective of the present study is the development of drought severity indicators. The accuracy of these indicators is tested by using historical data. Those indicators which accurately indicated past droughts were selected for further analysis.

Several time series, such as those listed above, can be used to develop drought severity indicators. Using all of them would involve considerable repetitious effort in data acquisition and analysis. Furthermore, they may give results which are not very different from each other. Consequently, the second objective of the present study is to investigate the consistency of results obtained by different time series. If the results from several series were found to be consistent with each other, then the series which is easiest to acquire, is recommended for use.

2. The Data Base

For most of the drought indicators, daily data are the primary series available for analysis. Daily values reflect short term conditions, which does not reflect the long term conditions needed for development of droughts. Consequently, monthly series derived from daily series were used in the analysis.