Drought-Influenced Low-Flow Non-Exceedance Plots for Selected USGS Gauges in Oklahoma

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Introduction
Planning for water use during drought periods is an important public good that is rarely achieved.

Climate change predictions for Oklahoma include shifts from the current norm precipitation regime to include long dry periods and drought, interspersed with intense wet periods (AMS, 2013). Additionally, projected warming trends will likely mean reduced snowpack depths in mountain areas, and thus changes in the volume and timing of snowmelt to streams (AMS, 2013). These changes and others are likely to manifest themselves in Oklahoma streamflows. Published streamflow statistics for Oklahoma do not account for the influences of drought (Lewis and Esralew, 2009).

The objective of this project was to begin to develop streamflow models and tools that will allow Oklahoma planners and citizens to estimate the effects of drought on streams, and therefore help in planning for the effects of drought.

Oklahoma Climate Divisions

Barren Fork Creek near Eldon, OK Streamflow Record
Barren Fork Creek watershed is 312 mi² in the Ozark region of eastern Oklahoma and western Arkansas and is designated both as an Oklahoma Scenic River and a USGS reference stream (no dams or significant water diversions). It has continuous streamflow record from 1948 to the present (66 years).

Two Questions About Drought-influenced Streamflows

1. Are Low Flows Lower?
   Is there a difference in the lowest streamflows that would be important for planning?
   What are Low Flow Non-exceedance Plots?
   A statistical estimate of the annual lowest streamflows based on the existing record of streamflows. The plots produce probability and recurrence intervals for 7, 10, or 30 day moving averages.
   How are Low Flow Non-exceedance Plots Used?
   Any time an estimate of the risk of low flow occurrence is required, such as when assessing threats to aquatic organisms and their stream habitat, or maintaining water quality.
   Example: Regulatory Low Flow
   The water quality of receiving waters depends on the dilution of the wastewater. In Oklahoma the 7-day averaged low flow with a 2-year return interval (7Q2) is used to calculate the WQ sampling regime for wastewater discharges based on the risk of low flow volumes relative to discharge volume.

2. Are All Flows Lower?
   Flow Duration Curves graphically display the probability of streamflow magnitude. Is there a difference between drought-influenced and full-record streamflow that could be important for planning?
   What is a Flow Duration Plot?
   • Uses entire record of daily mean flows
   • Shows relative frequency of all recorded flows
   • Shape of a duration plot related to stream hydrology
     Steep portion indicates high variability: e.g. "Flashy" runoff
     Shallow indicate stable flows; e.g. Spring-fed or dam release

References


Comparison of “Normal” Exceedance

Flow Duration Conclusion
There is a difference between full-record and drought-influenced median flows. The 50% exceedance flow from Flow Duration table is an approximation of “drought influenced” median flow.

“Rule of Thumb” Median Drought Flow estimate
Low-flow risk can be estimated without creating the drought-influenced flow record.

1. Select USGS gauge from Statistical Summaries of Streamflows in and near Oklahoma (Lewis and Esralew, 2009)
2. Find Flow Duration table
3. Choose 60% exceedance flow

This simple tool is intended to help in the initial stages of drought planning by allowing a rough estimate for the expected reduction in streamflow magnitude. A subsequent hydrologic study would provide more specific information better suited to final decisions.

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